British Medical Association.

REPORT

OF

The Committee on Treatment of Simple Fractures.

CONCLUSIONS.

The following are the main Conclusions deduced from an analysis and full consideration by the Committee of the material collected by the Committee's Investigators :—

I. The statistics relative to the non-operative treatment of fractures of the shafts of the long bones in children (under the age of 15 years), with the exception of fractures of both bones of the forearm, show as a rule a high percentage of good results. These are unlikely to be improved upon materially by any other method of treatment. Operative results in children, expressed in percentages, are approximately the same as the non-operative. The relative figures are :—

NON-OPERATIVE CASES (Cases, 1,017) 90·5% good functional results (*See* Table V., page 1526.)

OPERATIVE CASES (Cases, 64) 93·6 % good functional results. (*See* Table V., page 1526.)

II. It is possible either by non-operative or by operative treatment to obtain a high percentage of good results in children.

III. In comparison with the non-operative results in children, the aggregate results of non-operative treatment in those past childhood (*i.e.*, over the age of 15 years) are not satisfactory. (*See* Table V., page 1526.)

IV. From the analysis of the age groups it is clear that there is a progressive depreciation of the functional result of non-operative treatment as age advances, that is to say, the older the patient the worse the result. (*See* Table VI., page 1526.)

V. In cases treated by immediate operation, the deleterious influence of age upon the functional result is less marked.

VI. In nearly all age groups, operative cases show a higher percentage of good results than non-operative cases (*See* Table I., page 1508.)

VII. Although the functional result may be good with an indifferent anatomical result, the most certain way to obtain a good functional result is to secure a good anatomical result. (*See* 1st paragraph, page 1525.)

VIII. No method, whether non-operative or operative, which does not definitely promise a good anatomical result, should be accepted as the method of choice. For this reason mobilisation and massage by themselves have not been found to secure a high percentage of good results. They are, however, valuable supplementary methods of treatment.

Similarly, of operative methods, those which secure reposition and absolute fixation of the fragments yield better results than methods which fall short of this; imperfect fixation of the fragments by wire or other suture has been found to be an unsatisfactory procedure in the treatment of fractures of the long bones, with the exception of the olecranon process of the ulna.

IX. Operative treatment should not be regarded as a method to be employed in consequence of the failure of non-operative measures, as the results of secondary operations (Classes B and C) compare very unfavourably with those of immediate operations (Class A). (*See* Table IV., page 1525.)

In order to secure the most satisfactory results from operative treatment, it should be resorted to as soon after the accident as practicable.

X. It is necessary to insist that the operative treatment of fractures requires special skill and experience, and such facilities and surroundings as will ensure asepsis. It is, therefore, not a method to be undertaken except by those who have constant practice and experience in such surgical procedures.

XI. A considerable proportion of the failures of operative treatment are due to infection of the wound, a possibility which may occur even with the best technique.

XII. The mortality directly due to the operative treatment of simple fractures of the long bones has been found to be so small that it cannot be urged as a sufficient reason against operative treatment. (*See* Table X., page 1528.)

XIII. For surgeons and practitioners who are unable to avail themselves of the operative method, the non-operative procedures are likely to remain for some time yet the more safe and serviceable.

INTRODUCTION.

The Fractures Committee, in presenting the Report on its investigation into the treatment of fractures pursuant to the instructions of the Council, desires to record its sense of obligation and thanks to all surgeons and surgical registrars who have so cordially granted facilities for the examination of patients and also to those who by clerical and other assistance have rendered the inquiry less onerous than it otherwise would have been.

The number of cases (over 2,900) on which the Report is based, and the wide geographical distribution of the centres of investigation, afford evidence that the results of all variations in treatment have been under review.

The analyses and deductions in respect of the non-operative cases are specially valuable, presenting, as they do, questions of great interest for deliberation.

With regard to operative treatment, it is a matter of regret that a much larger number than 208 have not been available for personal inspection. In this connection the Committee feels that it is unfortunate in being unable to include in the main Report the operative cases so kindly exhibited by Mons. A. Lambotte, of Antwerp, as the figures were made up and in type before the analysis of these additional cases could be completed. They are, however, analysed and appended to the *précis* on technique which Mons. Lambotte has been good enough to furnish and for which sincere thanks are due.

Mr. W. Arbuthnot Lane has also placed the Committee under a great obligation by acceding very cordially to a request for an account of his operative method.

The Committee very gratefully acknowledges its debt of gratitude to Mons. Just Lucas-Championnière for demonstrating a large number of radiographs and some cases, and for presenting a synopsis of his method for inclusion in this Report.

To Dr. F. Steinmann, of Bern, the Committee offers a warm recognition of his courtesy in supplying so generously an exposition of a procedure which is original and interesting.

The sincere thanks of the Committee are also offered to Prof. B. Bardenheuer, of Cologne, for a valuable set of volumes and papers illustrative of his extension method of treatment. Extracts from these will be found in the Appendix to the Report.

The Committee desires to mark their appreciation of the valuable services rendered by Sister May Sinzininex, who has with great care and accuracy analysed and tabulated the material embodied in the Report.

The thanks of the Committee and Association are due to Dr. A. D. Macpherson, Assistant Medical Secretary, and the office staff, for their untiring efforts on behalf of the enquiry. It would be impossible to name individually all others who have assisted, but it is hoped that they will accept this record of the grateful thanks of the Committee.

PART I.—PRELIMINARY CONSIDERATIONS.

The Committee was appointed by the Council of the British Medical Association in response to a recommendation to that effect by the Section of Surgery at the Annual Meeting of the Association held in July, 1910. The reference from the Council to the Committee was—

"To report on the ultimate results obtained in the treatment of simple fractures with or without operation."

The following are the members of the Committee:—Mr. W. J. Greer, Newport, Mon., *Chairman;* Mr. J. Grant Andrew, Glasgow; Mr. Charles W. Cathcart, Edinburgh; Mr. H. S. Clogg, London; Mr. Edward Deanesly, Wolverhampton; Mr. C. H. Fagge, London; Sir Victor Horsley, F.R.S., London; Prof. J. Rutherford Morison, Newcastle-on-Tyne; Mr. Herbert J. Paterson, London; Mr. P. W. G. Sargent, London; Mr. W. Taylor, Dublin; Mr. Wilfrid Trotter, London; Mr. Richard Warren, London: with the following *ex-officio*:—Prof. Robert Saundby, M.D., Birmingham, *President of the Association;* Dr. Ewen J. Maclean, Cardiff, *Chairman of Representative Meetings;* Dr. J. A. Macdonald, LL.D., Taunton, *Chairman of Council;* Dr. Edwin Rayner, Stockport, *Treasurer.*

The Committee was appointed in February, 1911, and held its first meeting in March, 1911.

The Committee decided to limit the inquiry to simple fractures of the long bones which occurred, or in which operations had been performed, in the period January, 1906, to December, 1910, inclusive. This period was chosen in order that no patient should be examined until at least six months had elapsed since the commencement of treatment.

A notice as to the formation of the Committee and its reference was published in the BRITISH MEDICAL JOURNAL and *Lancet* of April 8th, 1911, with a request to hospital surgeons and other practitioners interested kindly to communicate with the Committee if they could afford facilities for the examination of cases.

Subsequently the surgeons on the staffs of the general hospitals in the following towns were approached, through the respective surgical registrars, and asked to assist in the inquiry by affording access to their case books with a view to the examination of their patients and records by members of the Committee:—Birmingham, Bristol, Dublin, Edinburgh, Glasgow, Leeds, Leicester, Liverpool, London, Manchester, Newcastle, and Sheffield.

Investigations were conducted at the following hospitals, the number of patients (or records of cases, in the case of patients deceased) examined at each hospital being indicated in brackets:—Birmingham—General Hospital (116); Bristol—General Hospital (101), Royal Infirmary (151); Dublin—Adelaide Hospital (4), Dr. Steevens' Hospital (31) Mercers' Hospital (7): Edinburgh—Royal Infirmary (131); Glasgow—Victoria Infirmary (100); Leeds—General Infirmary (324); London—Charing Cross Hospital (54), Guy's Hospital (423), Great Ormond Street Hospital (32); London Hospital (358); Metropolitan Hospital (20), St George's Hospital (133), St. Thomas's Hospital (323); University College Hospital (28); Newcastle-on-Tyne—Royal Victoria Infirmary (50); Sheffield—Royal Infirmary (225).

METHOD OF INVESTIGATION.

The hospitals indicated were visited on certain days by two or more members of the Committee (referred to in this Report as "investigators.") Every patient whose case forms a part of the Report was seen and examined by a member of the Committee. The details of the cases were filled in on the inquiry form, a copy of which is appended. (See Appendix A.)

It is obvious that some allowance must be made for individual variation of judgment of the investigators as to the verdict on each patient, but after frequent discussions on the subject the Committee is of opinion that fair uniformity of standard has been secured. With regard to the terms good, moderate, bad, used by the investigators, the one to which the most precise significance can be attached is that in which a case is noted as having a good anatomical and a good functional result. This may be taken to imply that such result was perfect, or nearly so.

In no instance is the report of a case that of the surgeon who treated the patient.

The importance of guarding against the cases being in any way selected, either accidentally or otherwise, was kept before the Committee. All the patients who attended were examined and reported upon, if adequate information were available. Certain circumstances, however, tended to lead to the cases available for report at any given institution not being absolutely representative of the whole results of the institution. For example the necessary fixing of definite times of attendance caused the numbers available to include an excessive proportion of children, and so influences the results favourably. Again, the same circumstance led to the attendance of an undue proportion of adults more or less incapacitated or out of work. This would tend to influence the total results unfavourably. The cases reported on at Newcastle-on-Tyne were representative in an exceptional degree, as the visit of the investigators coincided with the coal strike, so that a large number of men normally in full work were able to attend. Taking these circumstances together, the Committee is of opinion that no serious fallacy is involved in utilising the results as recorded.

1. MATERIAL.—Exclusive of cases investigated abroad, 2,948 patients attended for examination, making, together with the cases fatal during treatment, a total of 3,062 cases investigated in the United Kingdom. The inquiry forms relating to 122 of these were rejected by the Committee on account of insufficient details or because they did not come within the definition as to time limit or variety laid down by the Committee. A return was obtained from each hospital giving the total number of cases coming under the reference and treated during the period under review, the forms containing also details of all fatal cases occurring during the period. The Report is based on 2,940 cases personally investigated.

The following are the numbers of fractures of the different bones examined:—Femur, 897; tibia, 485; fibula, 274; tibia and fibula, 831; humerus, 302; ulna, 80; radius, 123; ulna and radius, 109.

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2. DEFINITION OF TERMS AND METHODS OF ANALYSIS.

(i.) Operative treatment is defined as including any operation in which the seat of fracture is exposed with a view to reposition of the fragments.

(ii.) Three classes of cases are distinguished under operative treatment, namely :—

(a) Those cases in which operation is decided upon at once and is performed as soon as practicable. (**Class A.**)

(b) Those cases in which operation is performed on account of failure to obtain and maintain accurate apposition by means of external mechanical appliances. (**Class B.**)

(c) Those cases in which operation is performed for non-union, for deficient union, or for faulty union, whether in progress or complete. (**Class C.**)

Classes B. and C. consist of cases in which, in the judgment of the surgeon, non-operative treatment has failed, such failure being the reason for operation. It seems to the Committee that in these cases the opinion of the surgeon in charge should be accepted as a sound judgment upon the unsatisfactory nature of the primary non-operative treatment. These cases, then, are clearly failures of non-operative treatment. The Committee, however, has deemed it undesirable to include them under the non-operative cases, as the non-operative result was not seen by the investigator. As a matter of fact the number of such cases is so small that the inclusion of them would, as has been proved by calculation, have merely a fractional influence on the percentages. For these reasons classes B. and C. have been kept separate, and are available for comparison with the A. group of operative cases.

(iii.) It is deemed undesirable to include under the general head of operative treatment of fractures subsidiary operations such as are not covered by the definition contained in Paragraph (i.). This will apply to such treatment as :— (a) Tenotomies, (b) Osteotomies, (c) Excision of Joints, (d) Removal of callus or of projecting fragments, (e) Freeing of nerves. Cases in which a subsidiary operation has been performed are necessarily included in the non-operative material.

It is with Class A only, in the judgment of the Committee, that the results in non-operative cases should be compared.

3. NON-OPERATIVE TREATMENT.—Two types of non-operative treatment are generally recognised, namely :—

(a) In which fixation is adopted immediately, and is continued until union has taken place.
(b) In which mobilisation is adopted.

Massage may be practised in combination with either of these methods.

It was hoped to draw a sharp distinction between those cases in which massage had been one of the chief lines of treatment from the beginning, and those in which massage had been practised as subsidiary to other treatment; but the material was so small, and exact details so deficient, that the Committee had to relinquish this design.

4. The Committee was of opinion that as a supplementary inquiry an effort might be made to show the influence on the ultimate result of primary replacement of the fragments by manipulation under an anæsthetic, when controlled by X-ray evidence. This was found to be impracticable.

Classification according to the exact form of the fracture was not possible, owing to the paucity of detail, and it was not practicable to obtain any valuable information as to the correlation of the occupation of the patient with the degree of success which attended the treatment.

5. The non-operative and operative material is analysed on exactly parallel lines.

The Committee wishes to point out that the operative material available within the years selected is so small that it is undesirable to attempt to draw any final conclusion from this material, as to the relative value of operative and non-operative treatment. The results are given in comparable form for what they are worth, but the Committee wishes emphatically to state its opinion that the chief value of its Report lies in the data collected and analysed as to the result of non-operative treatment.

It may be pointed out that the collection of facts relating to the non-operative treatment of fractures is a very large one, and such as yields conclusions which have a considerable degree of finality. Thus, at any time in the future, further results of operative treatment could be analysed on the same basis and compared with them, and the relative value of the methods finally ascertained.

6. The primary headings under which the material is analysed are the individual fractures as indicated below, not the individual bones.

7. Conclusions as to the efficiency of treatment can be deduced only from :—

(i.) The diagram of the result (see page 1 of the inquiry form printed in Appendix (A)) filled in by the Investigator.
(ii.) Duration of absence from work.

8. It is obvious that (i.) embodies the chief material, and represents the considered judgment of the investigator (in doubtful cases of two investigators), formed as a result of his personal examination of the patient. In this judgment the wage earning capacity of the patient has been taken into account. The duration of the patient's incapacity to follow his or her usual occupation has, on the other hand, a certain independent value, and must therefore be considered separately. It must be recognised, however, that this period is not solely dependent upon the nature of the injury or the treatment adopted, but varies greatly with the temperament of the patient, the nature of his employment, and the attitude of the employer and of the employee as to compensation.

Unfortunately, the details as to the period of incapacitation are available only in a small proportion of the cases. The result of this is that while the non-operative material is sufficiently large to yield a fairly reliable numerical value for the average length of convalescence—the operative is so small that no corresponding figure of any value can be obtained. Of the various ways in which the results—as to the length of incapacitation—might be stated, the Committee has thought it desirable to give two, namely :—

(a) The average time of absence from work in those cases in which a good functional result had been obtained at the time at the Committee's examination.

(b) The percentage of cases of any given fractures in which permanent incapacitation was the result of the injury. (See Tables VII. and VIII. pages 1526-27.)

9. For each separate variety of fracture stated below a sheet has been drawn up, separate sheets for non-operative and operative treatment, for male and female patients, and for every age sub-division. (See Appendix (B).)

10. The Committee adopted the following Sub-Division of Fractures :—

SCHEDULE OF FRACTURES.

(I.)—*Femur.*

(a) Fractures of neck.
(b) Separated epiphysis of head (with or without fracture).
(c) Fracture of upper third of shaft.
(d) Fracture of middle of shaft.
(e) Fracture of lower third of shaft.
(f) Fracture of lower extremity involving knee joint.
(g) Separated lower epiphysis (with or without fracture).

(II.)—*Tibia.*

(a) Separated upper epiphysis (with or without fracture).
(b) Fracture of shaft.
(c) Separated lower epiphysis (with or without fracture).
(d) Internal malleolus.

(III.)—*Fibula.*

(a) Separated upper epiphysis (with or without fracture).
(b) Fracture of shaft.
(c) Separated lower epiphysis (with or without fracture).

(IV.)—*Tibia and Fibula.*

(a) Fracture of shafts of both bones.
(b) Pott's fracture.

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(V.)—*Humerus.*

(a) Anatomical neck.
(b) Separated upper epiphysis (with or without fracture).
(c) Fracture of tuberosity.
(d) Fracture of surgical neck.
(e) Fracture of shaft.
(f) Supra of condylic fracture.
(g) Separated lower epiphysis (with or without fracture).
(h) Internal condyle; external condyle, capitellum.

(VI.)—*Radius.*

(a) Separated upper epiphysis (with or without fracture).
(b) Fracture of shaft.
(c) Separated lower epiphysis (with or without fracture).

VII.—*Ulna.*

(a) Fracture of olecranon.
(b) Fracture of shaft.
(c) Separated lower epiphysis (with or without fracture).

(VIII.)—*Radius and Ulna.*

(a) Fracture of shafts of both bones.
(b) Colles's Fracture.

Age Groups.

11. The Committee considered it to be of great importance to ascertain the influence of age on fractures treated on similar lines and accordingly adopted a detailed sub-division of age groups as follows:—

(a) 0 to 10 years.
(b) 11 to 15 ,,
(c) 16 to 20 ,,
(d) 21 to 25 ,,
(e) 26 to 45 ,,
(f) 46 to 60 ,,
(g) 61 years and over.

PART II.—ANALYSIS OF MATERIAL.

[1. ABSTRACTS OF INQUIRY FORMS FOR EACH FRACTURE.

In Table I. are given the results of the treatment of the various fractures arranged in age groups. The totals for each age group, and in addition the totals for I. Non-Operative cases, and II. Immediate Operative cases (Class A) are given.

The totals for the B and C operative classes are given separately.

After the operative cases, the number of cases in which a subsidiary operation was performed is indicated.

In the percentages given at the end of each group of non-operative cases, subsidiary operations are included, in accordance with the decision of the Committee set out in paragraph 2 (iii) of the Report. The percentages, therefore, in the two columns referring to the non-operative cases indicate (1) The percentage of non-operative cases (including subsidiary operations) in which the anatomical and the functional result was good, (2) The percentage of cases in which the functional result was good, but the anatomical result moderate or bad. The two percentages added together give the total percentage in which a good functional result was obtained irrespective of the anatomical result.

TABLE I.

ABSTRACTS OF ENQUIRY FORMS.

Fracture.	Age Group (Years).	No. of Cases.	Anatomical Result.			Functional Result.			Percent. of Good Anat. and Good Funct.	Percent. of Mod. or Bad Anat. with Good Funct.
			Good	Mod.	Bad	Good	Mod.	Bad		
I. (a) Femur—Neck. I. Non-Operative	0-10 M.	3	3	—	—	3	—	—		
	11-15 M.	1	—	1	—	1	—	—		
	16-20 M.	1	—	1	—	1	—	—		
	26-45 M.	14	4	7	3	5	4	5		
	26-45 F.	6	—	3	3	1	1	4		
		20	4	10	6	6	5	9		
	46-60 M.	20	4	10	6	5	7	8		
	46-60 F.	10	3	2	5	3	3	4		
		30	7	12	11	8	10	12		
	61 M.	15	1	7	7	2	5	8		
	61 F.	21	3	8	10	3	8	10		
		36	4	15	17	5	13	18		
Total	(M. & F.)	91	18	39	34	24	28	39	16·4 %	9·8 %
II. Operative A.	0-10 M.	1	1	—	—	1	—	—	100 %	
B.	46-60 F.	1	1	—	—	—	1	—		
I. (b) Femur—Separated Epiphysis of Head. I. Non-Operative	11-15 M.	4	2	2	—	3	1	—		
	11-15 F.	1	1			1				
		5	3	2	—	4	1	—		
	16-20 M.	4	1	2	1	2	—	2		
Total	(M.&F.)	9	4	4	1	6	1	2	44·4 %	22·2 %
I. (c). Femur—Upper third of Shaft. I. Non-Operative.	0-10 M.	27	25	1	1	27	—	—		
	0-10 F.	15	12	2	1	13	2	—		
		42	37	3	2	40	2	0		
	11-15 M.	3	3	—	—	3	—	—		
	11-15 F.	2	1	1	—	2	—	—		
		5	4	1	—	5	—	—		
	16-20 M.	5	2	3	—	4	1	—		
	21-25 M.	2	2	—	—	2	—	—		
	26-45 M.	9	2	2	5	6	1	2		
	26-45 F.	4	1	2	1	2	1	1		
		13	3	4	6	8	2	3		
	46-60 M.	17	4	6	7	6	6	5		
	46-60 F.	4	—	2	2	2	—	2		
		21	4	8	9	8	6	7		
	61 M.	4	1	1	2	1	0	3		
	61 F.	4	—	3	1	—	4	—		
		8	1	4	3	1	4	3		
Total	(M. & F.)	96	53	23	20	68	15	13	54·1%	4·2 %
B.	—	1	1	—	—	1	—	—		
C.	—	7	—	2	5	2	—	5		
Total	(M. & F.)	104	54	25	25	71	15	18	50·9%?	

Fracture.	Age Group (Years).	No. of Cases.	Anatomical Result.			Functional Result.			Percent. of Good Anat. and Good Funct.	Percent. of Mod. or Bad Anat. with Good Funct.
			Good	Mod.	Bad	Good	Mod.	Bad		
I. (c). Femur—Upper third of Shaft. —*continued.*										
II. Operative A.	0-10 M.	2	2	—	—	2	—	—		
	11-15 M.	1	1	—	—	1	—	—		
Total	(M. & F.)	3	3	—	—	3	—	—	100%	
B.	11-15 F.	1	1	—	—	1	—	—		
C.	11-15 M.	1	—	1	—	1	—	—		
	16-20 M.	1	—	1	—	1	—	—		
	26-45 F.	1	—	—	1	—	—	1		
	46-60 M.	4	—	—	4	—	—	4		
Total C.	(M. & F.)	7	—	2	5	2	—	5		
I. (d) Femur—Middle third of Shaft.										
I. Non-Operative	0-10 M.	216	198	16	2	211	5	—		
	0-10 F.	49	44	5	0	42	5	2		
		265	242	21	2	253	10	2		
	11-15 M.	57	41	13	3	53	4	—		
	11-15 F	6	4	1	1	5	—	1		
		63	45	14	4	58	4	1		
	16-20 M.	27	3	17	7	19	6	2		
	16-20 F.	2	2	—	—	2	—	—		
		29	5	17	7	21	6	2		
	21-25 M.	7	1	3	3	4	2	1		
	21-25 F.		—	—	—	—	—	—		
		7	1	3	3	4	2	1		
	26-45 M.	29	7	13	9	13	12	4		
	26-45 F.	3	2	1	—	2	1	—		
		32	9	14	9	15	13	4		
	46-60 M.	25	2	9	7	11	8	6		
	46 60 F.	5	—	3	2	—	—	5		
		30	9	12	9	11	8	11		
	61-M.	9	2	3	4	2	5	2		
	61-F.	1	1	—	—	—	1	—		
		10	3	3	4	2	6	2		
Total	(M.&F.)	436	314	84	38	364	49	23	67·8 %	13·2 %
B.		10	6	3	1	6	2	2		
C.		9	4	2	3	7	—	2		
Subsidiary		2	—	—	2	—	—	2		
		457	324	89	44	377	51	29	67·1 %	
II. Operative— A.	0-10 M.	17	16	1	—	16	1	—		
	0-10 F.	5	5	—	—	5	—	—		
		22	21	1	—	21	1	—		
	11-15 M.	3	3	—	—	3	—	—		
	16 20 M.	1	1	—	—	1	—	—		
	16 20 F.	1	—	1	—	—	1	—		
		2	1	1	—	1	1	—		
Total	(M.& F.)	27	25	2	—	25	2	—	92·5 %	

Fracture.	Age Group (Years).	No. of Cases.	Anatomical Result.			Functional Result.			Percent. of Good Anat. and Good Funct.	Percent. of Mod. or Bad Anat. with Good Funct.
			Good	Mod.	Bad	Good	Mod.	Bad		
I. (d) Femur—Middle third of Shaft. —*continued.*										
B.	0-10 M.	2	2	—	—	2	—	—		
	0-10 F.	—	—	—	—	—	—	—		
	11-15 M.	3	2	1	—	2	1	—		
	11-15 F.	1	1	—	—	1	—	—		
		4	3	1	—	3	1	—		
	16-20 M.	1	1	—	—	1	—	—		
	16-20 F.	1	—	1	—	—	1	—		
		2	1	1	—	1	1	—		
	26-45 M.	2	—	1	1	—	—	2		
Total	(M. & F.)	10	6	3	1	6	2	2		
C.	0-10 M.	3	3	—	—	3	—	—		
	0-10 F.	1	1	—	—	1	—	—		
		4	4	—	—	4	—	—		
	11-15 M.	2	—	1	1	1	—	1		
	16-20 F.	1	—	1	—	1	—	—		
	26-45 M.	2	—	—	2	1	—	1		
Total	M. & F.	9	4	2	3	7	—	2		
I. (e) Femur—Lower third of Shaft.										
I. Non-Operative	0-10 M.	29	28	1	—	28	1	—		
	0-10 F.	5	5	—	—	5	—	—		
		34	33	1	—	33	1	—		
	11-15 M.	11	7	3	1	10	—	1		
	11-15 F.	5	3	1	1	4	1	—		
		16	10	4	2	14	1	1		
	16-20 M.	9	5	3	1	9	—	—		
	16-20 F.	3	1	2	—	2	1	—		
		12	6	5	1	11	1	—		
	21-25 M.	—	—	—	—	—	—	—		
	21-25 F.	1	—	1	—	1	—	—		
	26-45 M.	1	—	—	1	1	—	—		
	26-45 F.	15	5	6	4	7	6	2		
		16	5	6	5	8	6	2		
	46-60 M.	10	5	2	3	5	5	0		
	46-60 F.	5	2	2	1	2	2	1		
		15	7	4	4	7	7	1		
	61 M.	4	1	1	2	1	1	2		
	61 F.	6	1	2	3	2	2	2		
		10	2	3	5	3	3	4		
Total	M. & F.	104	63	24	17	77	19	8	58·6%	15·3%
B.	—	2	1	1	—	1	1	—		
C.	—	4	1	—	3	1	2	1		
		110	65	25	20	79	22	9	55 4%	
II. Operative— A.	11-15 M.	1	1	—	—	1	—	—		
	16-20 M.	1	—	—	1	—	1	—		
Total	—	2	1	—	1	1	1	—		
B.	0-10 M.	1	—	1	—	1	—	—		
B.	21-25 M.	1	1	—	—	—	1	—		
Total B.	—	2	1	1	—	1	1	—		
C.	11-15 M.	1	1	—	—	—	1	—		
	26-45 M.	1	—	—	1	—	—	1		
	46-60 F.	2	—	—	2	1	1	—		
Total C.	(M, & F.)	4	1	—	3	1	2	1		

Fracture.	Age Group (Years).	No. of Cases.	Anatomical Result.			Functional Result.			Percent. of Good Anat. and Good Funct.	Percent. of Mod. or Bad Anat. with Good Funct.
			Good	Mod.	Bad	Good	Mod.	Bad		
I. (f) Femur—Lower Extremity involving Knee-joint										
I. Non-Operative	0-10 M.	1	1	—	—	1	—	—		
	11-15 M.	1	1	—	—	1	—	—		
	16-20 M.	1	—	1	—	1	—	—		
	21-25 M.	1	—	—	1	—	—	1		
	26-45 M.	3	3	—	—	3	—	—		
	46-60 M.	4	—	1	3	—	3	1		
	61- M.	1	—	—	1	—	—	1		
Total M.	(no F.)	12	5	2	5	6	3	3	41· %	8·3%
B.		4	—	1	3	—	2	2		
C.		2	—	1	1	—	1	1		
		18	5	4	6	6	6	6	27·7 %	
II. Operative—										
A.	26-45	1	—	1	—	—	1	—		
B. .. .	26-45 M.	1	—	—	1	—	—	1		
	46-60 F.	2	—	—	2	—	1	1		
Total	M. & F.	3	—	—	3	—	1	2		
C.	26-45 M.	1	—	1	—	—	1	—		
	46-60 M.	1	—	—	1	—	—	1		
Total	M. only	2	—	1	1	—	1	1		
I. (g) Femur—Lower Epiphysis										
I. Non-Operative	0-10 M.	4	4	—	—	4	—	—		
	0-10 F.	1	1	—	—	—	—	1		
		5	5	—	—	4	—	1		
	11-15 M.	3	1	—	2	2	1	—	55·5 %	11·1 %
Total	(M.& F.)	8	6	—	2	6	1	1		
C		1	—	—	1	—	—	1		
Subsidiary ..		1	1	—	—	—	1	—		
		10	7	—	3	6	2	1		
II. (b) Tibia—Shaft.										
I. Non-Operative	0-10 M.	119	114	4	1	117	1	1		
	0-10 F.	45	41	1	3	43	1	1		
		164	155	5	4	160	2	2		
	11-15 M.	47	45	1	1	45	0	2		
	11.15 F.	12	12	—	—	12	—	—		
		59	57	1	1	57	0	2		
	16-20 M.	32	24	6	2	29	1	2		
	16-20 F.	4	2	1	1	1	1	2		
		36	26	7	3	30	2	4		
	21-25 M.	18	14	3	1	16	1	1		
	21-25 F.	3	3	—	—	3	—	—		
		21	17	3	1	19	1	1		
	26-45 M.	58	35	21	2	43	11	4		
	26-45 F.	14	6	6	2	7	5	2		
		72	41	27	4	50	16	6		
	46-60 M.	46	22	18	6	29	10	7		
	46-60 F.	11	8	2	1	8	3	—		
		57	30	20	7	37	13	7		
	61 M.	8	4	2	2	5	1	2		
	61 F.	7	6	1	—	4	3	—		
		15	10	3	2	9	4	2		
Total	(M.& F.)	424	336	66	22	362	38	24	74·4 %	10·7 %
B.		2	—	1	1	1	1	—		
C.		1	1	—	—	1	—	—		
Subsidiary		2	—	1	1	—	1	1		
		429	337	68	24	364	40	25		

Fracture.	Age Group (Years).	No. of Cases.	Anatomical Result.			Functional Result.			Percent. of Good Anat. and Good Funct.	Percent. of Mod. or Bad Anat. with Good Funct.
			Good	Mod.	Bad	Good	Mod.	Bad		
II. (b) Tibia—Shaft —continued.										
II. Operative										
A.	0-10 M.	6	6	—	—	6	—	—		
	11-15 M.	1	1	—	—	1	—	—		
	21 25 M.	1	—	1	—	1	—	—		
	26-45 M.	3	3	—	—	3	—	—		
	26-45 F.	1	1	—	—	1	—	—		
		4	4	—	—	4	—	—		
	46-60 M.	3	2	1	—	2	—	1		
	46-60 F.	1	—	—	1	1	—	—		
		4	2	1	1	3	—	1		
	61 M.	—	—	—	—	—	—	—		
	61 F.	1	—	1	—	1	—	—		
		17	13	3	1	16	—	1	76·4 %	17·6 %
..	11-15 M.	1	—	1	—	1	—	—		
	26-45 M.	1	—	—	1	—	1	—		
		2	—	1	1	1	1	—		
C.	26-45 M.	1	1	—	—	1	—	—		
II. (c) & (d) Tibia—Various. Lower Epiphysis.										
I. Non-Operative	0-10 M.	1	1	—	—	1	—	—		
	0-10 F.	1	1	—	—	1	—	—		
		2	2	—	—	2	—	—		
	16-20 M.	1	1	—	—	1	—	—		
Total	(M.& F.)	3	3	—	—	3	—	—	100 %	
Tibia—Internal Malleolus.	26-45 M.	2	1	1	—	1	1	—	50 %	
Fibula—Malleolus.	46-60 F.	1	1	—	—	1	—	—		
	61-F.	1	1	—	—	1				
		2	2	—	—	2	—	—	100 %	
III (b) Fibula—Shaft.										
I. Non-Operative	0-10 M.	5	5	—	—	5	—	—		
	0-10 F.	2	2	—	—	2	—	—		
		7	7	—	—	7	—	—		
	11-15 M.	3	2	—	1	1	2	—		
	11-15 F.	1	1	—	—	1	—	—		
		4	3	—	1	2	2	—		
	16-20 M.	4	4	—	—	4	—	—		
	16-20 F.	1	1	—	—	1	—	—		
		5	5	—	—	5	—	—		
	21-25 M.	8	7	1	—	7	1	—		
	26-45 M.	56	45	9	2	48	4	4		
	26-45 F.	17	14	2	1	10	5	2		
		73	59	11	3	58	9	6		
	46-60 M.	34	30	2	2	26	4	4		
	46-60 F.	8	6	2	—	2	4	2		
		42	36	4	2	28	8	6		
	61- M.	9	7	2	—	5	1	3		
	61- F.	4	3	—	1	2	1	1		
		13	10	2	1	7	2	4		
Total	(M.& F.)	152	127	18	7	114	22	16	70·5 %	3·9 %
Subsidiary Op. ..	—	1	—	—	1	—	1	—		
		153	127	18	8	114	23	16		
II. Operative—										
A.	26-45 F.	1	1	—	—	1	—	—	100 %	

Fracture.	Age Group (Years).	No. of Cases.	Anatomical Result.			Functional Result.			Percent. of Good Anat. and Good Funct.	Percent. of Mod. or Bad Anat. with Good Funct.
			Good	Mod.	Bad	Good	Mod.	Bad		
IV. (a) Tibia and Fibula—Shafts.										
I. Non-Operative	0-10 M.	61	52	6	3	56	4	1		
	0-10 F.	11	10	1	—	11	—	—		
		72	62	7	3	67	4	1		
	11-15 M.	40	32	5	3	38	1	1		
	11-15 F.	4	4	—	—	4	—	—		
		44	36	5	3	42	1	1		
	16-20 M.	31	22	5	4	26	5	—		
	16-20 F.	2	1	1	—	1	1	—		
		33	23	6	4	27	6	—		
	21-25 M.	23	9	10	4	18	3	2		
	21-25 F.	4	1	2	1	3	1	—		
		27	10	12	5	21	4	2		
	26-45 M.	161	60	64	37	111	36	14		
	26-45 F.	38	12	18	8	20	12	6		
		199	72	82	45	131	48	20		
	46-60 M.	84	30	31	23	58	12	14		
	46-60 F.	47	16	17	14	17	22	8		
		131	46	48	37	75	34	22		
	61- M.	25	7	10	8	14	9	2		
	61- F.	17	7	5	5	7	8	2		
		42	14	15	13	21	17	4		
Total	M. & F.	548	263	175	110	384	114	50	44·4 %	25·6 %
B.		18	4	9	5	12	4	2		
C.		17	4	7	6	9	1	7		
Subsidiary		1	—	—	1	—	—	1		
		584	271	191	122	405	119	60		
II. Operative— A.	0-10 M.	1	1	—	—	1	—	—		
	11-15 M.	1	1	—	—	1	—	—		
	16-20 F.	1	1	—	—	1	—	—		
	21-25 M.	3	3	—	—	3	—	—		
	26-45M.	9	5	2	2	6	2	1		
	26-45 F.	2	2	—	—	1	1	—		
		11	7	2	2	7	3	1		
	46-60 M.	3	3	—	—	1	2	—		
	61- M.	2	1	—	1	1	—	1		
Total	M. & F.	22	17	2	3	15	5	2	63·6 %	4·5 %
B.	11-15 M.	2	—	2	—	2	—	—		
	16-20 M.	3	1	2	—	3	—	—		
	26-45 M.	6	2	3	1	4	2	—		
	26-45 M.	2	1	—	1	2	—	—		
		8	3	3	2	6	2	—		
	46-60 M.	1	—	—	1	—	1	—		
	61- M.	4	—	2	2	1	1	2		
Total	M. & F.	18	4	9	5	12	4	2	16·6 %	50 %

Fracture.	Age Group (Years).	No. of Cases.	Anatomical Result.			Functional Result.			Percent. of Good Anat. and Good Funct.	Percent. of Mod. or Bad Anat. with Good Funct.
			Good	Mod.	Bad	Good	Mod.	Bad		
IV. (a) Tibia and Fibula—Shafts. II. Operative —*continued.*										
C.	0-10 M.	1	1	—	—	1	—	—		
	16-20 M.	3	1	1	1	2	—	1		
	21-25 M.	1	—	1	—	1	—	—		
	26-45 M.	7	2	3	2	4	1	2		
	26-45 F.	1	—	—	1	—	—	1		
		8	2	3	3	4	1	3		
	46-60 M.	3	—	1	2	1	—	2		
	61- F.	1	—	1	—	—	—	1		
Total	(M. & F.)	17	4	7	6	9	1	7	23·5 %	29·4 %
IV. (b) Pott's. I. Non-Operative	0-10 M.	1	1	—	—	1	—	—		
	11-15 M.	7	6	1	—	7	—	—		
	11-15 F.	1	1	—	—	1	—	—		
		8	7	1	—	8	—	—		
	16-20 M.	2	—	2	—	1	—	1		
	16-20 F.	2	1	1	—	1	1	—		
		4	1	3	—	2	1	1		
	21-25 M.	7	3	3	1	4	1	2		
	21-25 F.	4	2	2	—	2	2	—		
		11	5	5	1	6	3	2		
	26-45 M.	70	35	28	7	43	19	8		
	26-45 F.	43	27	10	6	19	14	10		
		113	62	38	13	62	33	18		
	46-60 M.	54	27	20	7	23	18	13		
	46-60 F.	29	13	12	4	9	13	7		
		83	40	32	11	32	31	20		
	61 M.	18	7	3	8	7	2	9		
	61 F.	8	1	5	2	1	3	4		
		26	8	8	10	8	5	13		
Total	(M. & F.)	216	124	87	35	119	73	54	37·5%	10·4%
B. ..		2	1	1	—	1	1	—		
C. ..		4	—	1	3	—	1	3		
Subsid. ..		2	—	1	1	—	1	1		
		254	125	90	39	120	76	58		
II. Operative—A.	16-20 M.	1	1	—	—	1	—	—		
	46-60 M.	2	1	1	—	—	1	1		
	46-60 F.	1	1	—	—	1	—	—		
		3	2	1	—	1	1	1		
Total	(M. & F.)	4	3	1	—	2	1	1	50%	
B.	26-45 M.	1	1	—	—	1	—	—		
	46-60 M.	1	—	1	—	—	1	—		
Total B.		2	1	1	—	1	1	—	50 %	
C.	26-45 M.	1	—	—	1	—	—	1		
	46-60 M.	2	—	—	2	—	—	2		
	61-M.	1	—	1	—	—	1	—		
Total C.		4	—	1	3	—	1	3		

Fracture.	Age Group (Years).	No. of Cases.	Anatomical Result.			Functional Result.			Percent. of Good Anat. and Good Funct.	Percent. of Mod. or Bad Anat. with Good Funct.
			Good	Mod.	Bad	Good	Mod.	Bad		
V. (a) Humerus—Anatomical Neck.										
I. Non-Operative	11-15 M	1	1	—	—	1	—	—		
	26-45 M	2	2	—	—	2	—	—		
	46-60 F.	1	1	—	—	1	—	—		
Total	—	4	4	—	—	4	—	—	80%	0·0%
Subsidiary	—	1	—	—	1	—	—	1		
II. Operative A.	46-60 M	1	1	—	—	1	—	—		
	46-60 F.	1	1	—	—	1	—	—		
		2	2	—	—	2	—	—	100%	
V. (b) Humerus—Upper Epiphysis.										
	0-10 M	1	1	—	—	1	—	—		
	0-10 F	3	2	—	1	3	—	—		
		4	3	—	1	4	—	—		
	16-20 M	1	1	—	—	1	—	—		
Total	(M. & F.	5	4	—	1	5	—	—	80%	20%
II. Operative A.	0-10 F.	1	1	—	—		—	—		
	16-20 M.	1	1	—	—	1	—	—		
		2	2	—	—	2	—	—	100%	
V. (c) Humerus—Tuberosity.										
I. Non-Operative	26-45 F.	1	1	—	—	1	—	—		
	46-60 M	1	—	1	—	—		—		
Subsidiary	46-60 M.	1	—	1	—	—		—		
		3	1	2	—	1	2	—		
V. (d) Humerus—Surgical Neck										
I. Non-Operative	0-10 M.	3	3	—	—	3	—	—		
	0-10 F.	1	1	—	—	1	—	—		
	11-15 M.	2	2	—	—	2	—	—		
	16-20 M.	4	2	1	1	4	—	—		
	26-45 M.	5	3	1	1	3	1	1		
	46-60 M.	6	5	1	—	6	—	—		
	16-60 F.	5	3	2	—	2	3	—		
	61-M.	7	1	4	2	3	1	3		
	61-F.	4	2	1	1	1	2	1		
Total	—	37	22	10	5	25	7	5	45·0%	17·5%
B.	—	4	4	—	—	4	—	—		
C.	—	3	2	1	—	3	—	—		
Subsidiary	—	3	—	1	2	—	—	3		
Total	—	47	28	12	7	32	7	8		
II. Operative A.	11-15 F.	1	1	—	—	1	—	—		
	16-20 M.	1	1	—	—	1	—	—		
	46-60 M.	1	—	—	1	—	—	1		
	46-60 F.	1	—	1	—	—	1	—		
		4	2	1	1	2	1	1		
	61-F.	1	1	—	—	1	—	—		
	61-M.	1	1	—	—	1	—	—		
Total A.	(M. & F.)	6	4	1	1	4	1	1	60%	
B.	0-10 M.	2	2	—	—	2	—	—		
	26-45 M.	2	2	—	—	2	—	—		
Total B.		4	4	—	—	4	—	—		
C.	11-15 M.	1	—	1	—	1	—	—		
	16-20 M.	1	1	—	—	1	—	—		
	26-45 M.	1	1	—	—	1	—	—		
Total C.	—	3	2	1	—	3	—	—		

Fracture	Age Group (Years).	No. of Cases	Anatomical Result.			Functional Result.			Percent of Good Anat. and Good Funct.	Percent. of Mod. or Bad Anat. with Good Funct.
			Good	Mod.	Bad	Good	Mod.	Bad		
V. (e) Humerus—Shaft.										
I. Non-operative	0-10 M.	7	6	1	—	7	—	—		
	0-10 F.	6	3	1	2	4	2	—		
		13	9	2	2	11	2	0		
	11-15 M.	5	2	3	—	4	1	—		
	16-20 M.	11	6	5	—	11	—	—		
	16-20 F.	1	1	—	—	1	—	—		
		12	7	5	—	12	—	—		
	21-25 M.	1	—	1	—	1	—	—		
	21-25 F.	2	—	1	1	1	1	—		
		3	—	2	1	2	1	—		
	26-45 M.	14	9	4	1	10	3	1		
	26-45 F.	1	1	—	—	1	—	—		
		15	10	4	1	11	3	1		
	46-60 M.	13	11	2	—	12	1	—		
	46-60 F.	4	3	1	—	3	1	—		
		17	14	3	—	15	2	—		
	61-M.	3	2	—	1	2	1	—		
Total	M. & F.	68	44	19	5	57	10	1	64·5%	21·9%
B.		7	6	1	—	6	—	1		
C.		6	4	2	—	2	2	2		
Subsidiary		5	3	—	2	3	2	—		
Total		86	57	22	7	68	14	4		
II. Operative— A.	16-20 M.	3	3	—	—	3	—	—		
	21-25 F.	1	1	—	—	1	—	—		
	26-45 M.	1	1	—	—	—	1	—		
	16-60 F.	1	1	—	—	1	—	—		
Total A.		6	6	—	—	5	1	—	83·3%	
B.	0-10 M.	1	1	—	—	1	—	—		
	16-20 M.	1	1	—	—	1	—	—		
	20-21 F.	1	1	—	—	1	—	—		
	26-45 M.	3	3	—	—	3	—	—		
	61-M.	1	—	1	—	—	—	1		
Total B.		7	6	1	—	6	—	1		
C.	0-10 F.	1	1	—	—	1	—	—		
	26-45 M.	1	—	1	—	1	—	—		
	16-60 M.	4	3	—	1	—	2	2		
Total C.		6	4	1	1	2	2	2		
V. (f) Humerus—Supra-condylic.										
I. Non-Operative.	0-10 M.	4	2	2	—	3	1	—		
	0-10 F.	2	2	—	—	2	—	—		
	11-15 M.	2	2	—	—	2	—	—		
	16-20 M.	4	—	4	—	1	3	—		
	21-25 M.	1	—	—	1	—	—	1		
	26-45 F.	1	—	—	1	—	—	1		
	46-60 M.	2	—	2	—	—	1	1		
	61 M.	1	1	—	—	1	—	—		
Total		17	7	8	2	9	5	3	41·1%	11·1%

Fracture.	Age Group (Years).	No. of Cases.	Anatomical Result.			Functional Result.			Percent. of Good Anat. and Good Funct.	Percent. of Mod. or Bad Anat. with Good Funct.
			Good	Mod.	Bad	Good	Mod.	Bad		
V. (f) Humerus—Supra-condylic. I. Non-Operative —*continued.*										
B.		5	2	—	3	2	2	1		
C.		1	1	—	—	—	1	—		
Subsid. ..		1	—	—	1	—	—	1		
		24	10	8	6	11	8	5		
II. Operative A.	11-15 M.	1	—	1	—	1	—	—		
B.	0-10 M.	2	—	—	2	1	1	—		
	16-20 M.	1	—	—	1	—	—	1		
	21-25 M.	1	1	—	—	1	—	—		
	46-60 M.	1	1	—	—	—	1	—		
		5	2	—	3	2	2	1		
C.	1-25M.	1	1	—	—	—	1	—		
V. Humerus—Various. Capitellum.										
II. Operative A.	0-10 M.	1	—	1	—	1	—	—		
V. (g) Humerus—Lower Epiphysis.										
I. Non-Operative	0-10 M.	28	17	5	6	23	4	1		
	0-10 F.	10	3	5	2	8	2	—		
		38	20	10	8	31	6	1		
	11-15 M.	9	4	3	2	5	2	2		
	16-20 M.	3	2	—	1	2	—	1		
		50	26	13	11	38	8	4	44·0%	22·0%
Subsid. ..		9	—	2	7	1	2	6		
B.		3	1	—	2	1	1	1		
C.		3	—	2	1	—	2	1		
		65	27	17	21	40	13	12		
II. Operative—A	0-10 M.	7	3	1	3	4	2	1		
	0-10 F.	3	3	—	—	3	—	—		
	15-20 M.	1	1	—	—	1	—	—		
	11-15 F.	3	2	1	—	1	2	—		
Total A.		14	9	2	3	9	4	1	57·1%	7·1%
B.	0-10 M.	2	1	—	1	1	1	—		
	11-15 M.	1	—	—	1	—	—	1		
Total B.		3	1	—	2	1	1	1		
C.	0-10 M.	1	—	1	—	—	1	—		
	16-20 M.	2	—	1	1	—	1	1		
Total C.		3	—	2	1	—	2	1		
V. (h) Humerus—Int. Condyle.										
I. Non-Operative	0-10 F.	1	—	1	—	1	—	—		
	0-10 M.	4	1	—	3	2	—	2		
	11-15 M.	6	4	2	—	5	1	—		
	16-20 M.	4	3	1	—	2	2	—		
	26-45 M.	1	1	—	—	1	—	—		
	61-0 M.	1	—	1	—	—	1	—		
		17	9	5	3	11	4	2	41·1%	23·5%
II. Operative B.		1	—	1	—	—	1	—		

Fracture.	Age Group (Years).	No. of Cases.	Anatomical Result.			Functional Result.			Percent. of Good Anat. and Good Funct.	Percent. of Mod. or Bad Anat. with Good Funct.
			Good	Mod.	Bad	Good	Mod.	Bad		
V. (h) Humerus—Ext. Condyle. I. Non-Operative	0-10 M.	2	1	1	—	2	—	—		
	11-15 M.	3	—	3	—	2	1	—		
	16-20 M.	1	—	1	—	—	1	—		
	21-25 M.	1	—	1	—	—	1	—		
Total		7	1	6	—	4	3	—	14·2%	28·5%
V. (e) (g) (d) (f) (c) (a). Humerus (various)—I. Non-Operative Subsid. Operation										
Shaft.	0-10 F.	1	1	—	—	1	—	—		
	11-15 M.	1	—	—	1	—	1	—		
	16-20 M.	1	—	—	1	—	1	—		
	21-25 M.	1	1	—	—	1	—	—		
	26-45 M.	1	1	—	—	1	—	—		
Total	(M. & F.)	5	3	—	2	3	2	—		
Lower Epiphysis	0-10 M.	4	—	1	3	1	—	3		
	16-20 M.	1	—	—	1	—	1	—		
	26-45 M.	2	1	—	1	1	—	1		
	16-20 F.	2	—	1	1	—	1	1		
Total	(M. & F.)	9	1	2	6	2	2	5		
Surgical Neck.	26-45 M.	1	—	—	1	—	—	1		
	16-60 M.	1	—	—	1	—	—	1		
	46-60 F.	1	—	1	—	—	—	1		
Total	(M & F.)	3	—	1	2	—	—	3		
Supra-condylic	46-60 M.	1	—	—	1	—	—	1		
Excision of Tuberosity	46-60 F.	1	—	1	—	—	1	—		
Anatomical Neck.	61-	1	—	—	—	—	—	—		
VI. (a) Radius—Upper Epiphysis. I. Non-Operative	0-10 M.	1	—	1	—	—	1	—		
	11-15 M.	1	1	—	—	1	—	—		
Total		2	1	1	—	1	1	—	50%	
VI. (b) Radius—Shaft. I. Non-Operative	0-10 M.	6	5	1	—	5	1	—		
	0-10 F.	7	5	2	—	6	1	—		
		13	10	3	—	11	2	—		
	11-15 M.	6	4	1	1	5	1	—		
	16-20 M.	10	6	3	1	7	3	—		
	16-20 F.	2	1	—	1	1	—	1		
		12	7	3	2	8	3	1		
	21-25 M.	2	1	—	1	2	—	—		
	21-25 F.	1	1	—	—	1	—	—		
		3	2	—	1	3	—	—		
	26-45 M.	3	1	2	—	2	1	—		
	26-45 F.	3	1	2	—	1	2	—		
		6	2	4	—	3	3	—		
	46-60 M.	3	—	—	3	—	1	2		
	46-60 F.	1	1	—	—	—	1	—		
		4	1	—	3	—	2	2		
	61-M.	1	1	—	—	1	—	—		
	61-F.	0	—	—	—	—	—	—		
Total	(M. & F.)	45	27	11	7	31	11	3	53·1%	12·7%
B... ..	—	3	—	—	3	2	—	1		
C.	—	4	—	3	1	1	3	—		
Subsidiary	—	2	1	—	1	1	—	1		
		54	28	14	12	35	14	5		

Fracture.	Age Group (Years).	No. of Cases.	Anatomical Result.			Functional Result.			Percent. of Good Anat. and Good Funct.	Percent. of Mod. or Bad Anat. with Good Funct.
			Good	Mod.	Bad	Good	Mod.	Bad		
VI. (b) Radius—Shaft. —*continued.*										
II. Operative										
A.	0-10 M.	1	1	—	—	1	—	—		
	11-15 M.	2	1	1	—	2	—	—		
	11-15 F.	1	1	—	—	1	—	—		
		3	2	1	—	3	—	—		
	21-25 M.	1	1	—	—	1	—	—		
	26-45 M.	1	—	—	1	—	—	1		
	26-45 F.	1	—	1	—	—	—	1		
		3	—	1	1	—	—	2		
Total A	(M & F.)	7	4	2	1	5	—	2	57·1%	14·2 %
B.	26-45 M.	1	—	—	1	1	—	0		
	46-60 F.	1	—	—	1	1	—	—		
Total B.	(M. & F.)	2	—	—	2	2	—	—	—	100 %
C.	21-25 F.	1	—	1	—	1	—	—		
	26-45 M.	4	—	2	2	—	3	1		
Total C.	(M.& F.)	5	—	3	1	1	3	1	—	25 %
VI. (c) Radius—Lower Epiphysis										
I. Non-Operative	0-10 M.	4	3	1	—	3	1	—		
	0-10 F.	1	1	—	—	—	1	—		
		5	4	1	—	3	2	—		
	11-15 M.	6	3	2	1	5	1	—		
	16-20 M.	3	3	—	—	3	—	—		
	17-20 F.	1	1	—	—	1	—	—		
		4	4	—	—	4	—	—		
Total	(M.&F.)	15	11	3	1	12	3	—	66·6 %	13·3 %
II. Operative— A.	0-10	1	1	—	—	1	—	—	100 %	
VII. (a) Ulna— Olecranon										
I. Non-operative	0-10 F.	1	—	1	—	1	—	—		
	11-15 M.	1	—	1	—	1	—	—		
	16-20 M.	3	3	—	—	3	—	—		
	21-25 F.	1	—	1	—	1	—	—		
	26-45 M.	6	3	3	—	4	1	1		
	46-60 M.	2	1	—	1	1	1	—		
	46-60 F.	2	1	1	—	2	—	—		
		4	2	1	1	3	1	—		
	61- M.	4	2	1	1	2	1	1		
Total	(M.&F.)	20	10	8	2	15	3	2	45 %	30 %
B.		12	11	—	1	9	1	2		
C.		6	4	1	1	3	1	2		
		38	25	9	4	27	5	6		

Fracture.	Age Group (Years)	No. of Cases	Anatomical Result.			Functional Result.			Percent of Good Anat. and good Funct.	Percent. of Mod. or Bad Anat. with Good Funct.
			Good	Mod.	Bad	Good	Mod.	Bad		
VII (a) Ulna— Olecranon —*continued.*										
II. Operative A.	0-10 M.	1	1	—	—	1	—	—		
	16-20 M.	1	1	—	—	1	—	—		
	21-25 M.	1	1	—	—	1	—	—		
	26-45 M.	11	10	1	—	9	2	—		
	26-45 F.	2	2	—	—	1	1	—		
		13	12	1	—	10	3	—		
	46-60 M.	2	2	—	—	2	—	—		
	61- F.	1	—	1	—	—	1	—		
Total	(M.&F.)	19	17	2	—	15	4	—	73·6 %	5·2 %
B.	26-45 M.	8	8	—	—	8	—	—		
	26-45 F.	1	1	—	—	—	1	—		
		9	9	—	—	8	1	—		
	46-60 M.	3	3	—	—	1	1	1		
		3	3	—	—	1	1	1		
Total B.		12	12	—	—	9	2	1		
C.	16-20 M.	1	1	—	—	—	1	—		
	26-45 M.	4	2	1	1	2	—	2		
	46-60 M.	1	1	—	—	1	—	—		
	46-60 F.	1	—	—	1	—	—	1		
Total C.		7	4	1	2	3	1	3		
VII. (b) Ulna—Shaft.										
I. Non-Operative	0-10 M.	6	6	—	—	5	1	—		
	0-10 M.	1	1	—	—	1	—	—		
		7	7	—	—	6	—	—		
	11-15 M.	3	1	1	1	3	—	—		
	21-25 M.	1	1	—	—	1	—	—		
	26-45 M.	2	2	—	—	2	—	—		
	26-45 F.	1	1	—	—	1	—	—		
		3	3	—	—	3	—	—		
	46-60 M.	1	—	1	—	—	1	—		
	46-60 F.	1	1	—	—	1	—	—		
	61.M.	2	2	—	—	2	—	—		
Total	(M & F.)	18	15	2	1	16	2	—	77·7%	11·1%
B. ..	—	2	—	1	1	—	1	1		
C. ..	—	2	—	1	1	1	—	1		
		22	15	4	3	17	3	2		
II. Operative— A. ..	61-M.	1	—	—	1	—	1	—		
B. ..	11-15 M.	1	—	—	1	—	1	—		
	46-60 M.	1	—	1	—	—	—	1		
Total B.	..	2	—	1	1	—	1	1		
C. ..	16-20 M.	1	—	1	—	1	—	—		
	26-45 M.	1	—	—	1	—	—	1		
Total C.	..	2	—	1	1	1	—	1		
VII. (c) Ulna—Lower Epiphysis.										
1. Non-Operative	11-15 M.	1	1	—	—	1	—	—		
	16-20 M.	1	1	—	—	1	—	—		
Total	..	2	2	—	—	2	—	—	100 %	

Fracture.	Age Group (Years).	No. of Cases.	Anatomical Result.			Functional Result.			Percent. of Good Anat. and Good Funct.	Percent. of Mod. or Bad Anat. with Good Funct.
			Good	Mod.	Bad	Good	Mod.	Bad		
VIII. (a) Radius & Ulna —Shafts.										
I. Non-Operative	0-10 M.	22	14	4	4	15	4	3		
	0-10 F.	7	4	1	—	6	—	1		
		29	18	5		21		4		
	11-15 M.	19	13	6		9	10	—		
	11-15 F.	6	3			4	1	1		
		25	16	8		13	11	1		
	16-20 M.	5	—	4	1	2	2	1		
	16-20 F.	1	—			1	—	—		
		6	—		1	3		1		
	21-25 M.	2	1	1		1	1	—		
	26-45 M.	7	1	4	2	2	4	1		
	46-60 M.	4	—	1	3	—	1	3		
	46-60 F.	3	1	2		2	1	—		
		7	1	3	3	2	2	3		
Total	M. & F.	76	37	26	13	42	24	0	28·0%	17·1%
B... ..	—	3		1	2	1	1	1		
C... ..	—	10	1	3	6	2	3	5		
	—	89	38	31	21	45	28	16		
II. Operative— A... ..	0-10 M.	1	1	—		1	—	—		
	11-15 M.	1	1	—	—	1	—	—		
	11-15 F.	2	2	—	—	2	—	—		
		3	3	—		3	—	—		
	16-20 M.	2	2	—	—	2	—	—		
	26-45 M.	2	—	2	—	—	2	—		
		2	—	2	—	—	2	—		
Total A.	M. & F.	8	6	2	—	6	2	—	75%	
B... ..	0-10 F.	1	—	1	—	1	—	—		
	11-15 M.	2	—	—	2	—	1	1		
Total B.	M. & F.	3	—	1	2	1	1	1		
C... ..	0-10 F.	2	1	1	—	1	1	—		
	11-15 M.	1	—	1	—	1	—	—		
	16-20 M.	2	—	—	2	—	—	2		
	26-45 M.	2	—	1	1	—	1	1		
	26-45 F.	1	—	—	1	—	1	—		
		3	—	1	2	—	2	1		
	46-60 M.	2	—	—	2	—	—	2		
Total C.	M. & F.	10	1	3	6	2	3	5		

Fracture.	Age Group (Years).	No. of Cases	Anatomical Result.			Functional Result.			Percent of Good Anat. and Good Funct.	Percent. of Mod. or Bad Anat. with Good Funct.
			Good	Mod.	Bad	Good	Mod.	Bad		
VIII. (b) Colles's Fracture.										
I. Non-Operative	0-10 M.	1	1	—	—	1	—	—		
	11-15 M.	3	3	—	—	3	—	—		
	16-20 M.	2	1	1	—	2	—	—		
	21-25 M.	2	2	—	—	2	—	—		
	21-25 F.	2	—	2	—	2	—	—		
		4	2	2	—	4	—	—		
	26-45 M.	14	3	8	3	6	5	3		
	26-45 F.	2	1	1	—	2	—	—		
		16	4	9	3	8	5	3		
	46-60 M.	7	1	4	2	4	2	1		
	46-60 F.	7	1	5	1	4	4	3		
		14	2	9	3	8	5	1		
	61- M.	2	—	2	—	—	2	—		
	61- F.	5	—	2	3	1	4	—		
		7	—	4	3	1	6	—		
Total	M. F.	47	13	25	9	27	16	4	27·6%	29·7%
C. ..	..	1	—	1	—	—	1	—		
Total	M. & F.	48	13	26	9	27	17	4		
II. Operative A.	46-60 F.	1	1	—	—	1	—	—		
C. ..	26-45 M.	1	—	1	—	—	1	—		

2. For convenience of reference, the results of each individual fracture are set out in squares (Table II).

In the case of each fracture it is possible, according to the method of investigation adopted, to have nine different results, viz. :—

Good anatomical with **good functional** result.
Moderate anatomical with **good functional** result
Bad anatomical with **good functional** result.

Good anatomical with **moderate functional** result.
Moderate anatomical with **moderate functional** result.
Bad anatomical with **moderate functional** result.

Good anatomical with **bad functional** result.
Moderate anatomical with **bad functional** result.
Bad anatomical with **bad functional** result.

The number of each of these results in each fracture investigated is indicated in the squares.

The anatomical results are noted in the horizontal spaces and the functional in the vertical spaces of the square.

The non-operative results are given first (I.).

The operative Class A. next (II.—Class A.).

The operative Classes B and C are given together.

TABLE II.

Femur—Neck.

I. Non Operative.

Cases: 91.

Functional.

Anatomical.	Good.	Mod.	Bad.
Good.	15	2	1
Mod.	8	19	12
Bad.	1	7	26

II Operative.

Class A.

Cases: 1.

Functional.

Anatomical.	Good.	Mod.	Bad.
Good.	1	0	0
Mod.	0	0	0
Bad.	0	0	0

Class B.

Case: 1. Good anat. with bad functional result.

Femur—Sep. Epiph. of Head.

I. Non-Operative.

Cases: 9.

Functional.

Anatomical.	Good	Mod.	Bad
Good	4	0	0
Mod.	2	1	1
Bad	0	0	1

II. Operative.

Cases: 0.

Femur—Upper ⅓ of Shaft.

I. Non-Operative.

Cases: 96.

Functional.

Anatomical.	Good	Mod.	Bad
Good	52	1	0
Mod.	12	10	1
Bad	4	4	12

II Operative.

Class A.

Cases: 3.

Functional.

Anatomical.	Good	Mod.	Bad
Good	3	0	0
Mod.	0	0	0
Bad	0	0	0

Classes B. and C.

Cases: 8.

Functional.

Anatomical.	Good	Mod.	Bad
Good	1	0	0
Mod.	2	0	0
Bad	0	0	5

Femur—Middle ⅓.

I. Non-Operative.

Cases: 438.

Functional.

Anatomical.	Good	Mod.	Bad
Good	297	14	3
Mod.	56	20	7
Bad	11	14	16

II. Operative.

Class A.

Cases: 27.

Functional.

Anatomical.	Good	Mod.	Bad
Good	25	0	0
Mod.	0	2	0
Bad	0	0	0

Classes B. and C.

Cases: 19.

Functional.

Anatomical.	Good	Mod.	Bad
Good	10	0	0
Mod.	2	2	1
Bad	1	0	3

Femur—Lower ⅓ of Shaft.

I. Non-Operative.

Cases: 104.

Functional.

Anatomical.	Good	Mod.	Bad
Good	61	1	1
Mod.	12	12	0
Bad	4	6	7

II. Operative.

Class A.

Cases: 2.

Functional.

Anatomical.	Good.	Mod.	Bad
Good	1	0	0
Mod.	0	0	0
Bad	0	1	0

Classes B. and C.

Cases: 6.

Functional.

Anatomical.	Good	Mod.	Bad
Good	0	2	0
Mod.	1	0	0
Bad	1	1	1

Lower Extremity of Femur—Involving Knee-Joint.

I. Non-Operative.

Cases: 12.

Functional.

Anatomical.	Good	Mod.	Bad
Good	5	0	0
Mod.	1	1	0
Bad	0	2	3

II. Operative.

Class A.

Cases: 1. Mod. anatomical with mod. functional result.

Classes B. and C.

Cases: 5.

Functional.

Anatomical.	Good	Mod.	Bad
Good	0	0	0
Mod.	0	1	0
Bad	0	1	3

Femur—Lower Epiphysis.

I. Non-Operative.

Cases: 9.

Functional.

Anatomical.	Good	Mod.	Bad
Good	5	1	1
Mod.	0	0	0
Bad	1	1	0

II. OPERATIVE.

Class A. = 0.

Class C.

Cases: 1. Bad anat. with bad functional result.

Tibia—Shaft.

I. NON-OPERATIVE.

Cases: 426.

Functional.

Anatomical.	Good	Mod.	Bad
Good	317	15	5
Mod.	41	17	9
Bad	5	7	10

II. OPERATIVE.

Class A.

Cases: 17.

Functional.

Anatomical.	Good	Mod.	Bad
Good	13	0	0
Mod.	2	0	1
Bad	1	0	0

Classes B. and C.

Cases: 3.

Functional.

Anatomical.	Good	Mod.	Bad
Good	1	0	0
Mod.	1	0	0
Bad	0	1	0

Tibia—Lower Epiphysis.

I. NON-OPERATIVE.

Cases: 3.

Functional.

Anatomical.	Good	Mod.	Bad
Good	3	0	0
Mod.	0	0	0
Bad	0	0	0

II. OPERATIVE.

No Cases.

Tibia—Internal Malleolus.

I. NON-OPERATIVE.

Cases: 2.

Functional.

Anatomical.	Good	Mod.	Bad
Good	1	0	0
Mod.	0	1	0
Bad	0	0	0

II. OPERATIVE.

No Cases.

Fibula—Shaft.

I. NON-OPERATIVE.

Cases: 153.

Functional.

Anatomical.	Good	Mod.	Bad
Good	108	14	5
Mod.	6	7	5
Bad	0	2	6

II. OPERATIVE.

Class A.

1 *Case*: Good—good.

Classes B. and C. = 0.

Fibula—External Malleolus.

I. Non-Operative.

2 *Cases*: Both good anat. with good functional result.

II. Operative.

No cases.

Tibia and Fibula, Shafts.

I. Non-Operative.

Cases: 549.

Functional.

Anatomical.	Good.	Mod.	Bad.
Good	244	17	2
Mod.	111	46	18
Bad	30	50	31

II. Operative.

Class A.

Cases: 22.

Functional.

Anatomical.	Good.	Mod.	Bad.
Good	14	3	0
Mod.	1	1	0
Bad	0	1	2

Classes B and C.

Cases: 35.

Functional.

Anatomical.	Good.	Mod.	Bad.
Good	7	1	0
Mod.	12	1	3
Bad	2	3	6

Pott's Fracture.

I. Non-Operative.

Cases: 248.

Functional.

Anatomical.	Good.	Mod.	Bad.
Good	93	24	8
Mod.	23	40	25
Bad	3	10	22

II. Operative.

Class A.

Cases: 4.

Functional.

Anatomical.	Good.	Mod.	Bad.
Good	2	1	0
Mod.	0	0	1
Bad	0	0	0

Classes B and C.

Cases: 6.

Functional.

Anatomical.	Good.	Mod.	Bad.
Good	1	0	0
Mod.	0	2	0
Bad	0	0	3

Humerus—Anatomical Neck.

I. Non Operative.

Cases: 5.

Functional.

Anatomical.	Good.	Mod.	Bad.
Good	4	0	0
Mod.	0	0	0
Bad	0	0	1

II. OPERATIVE.

Class A.

Cases: 2.

Functional.

Anatomical.	Good	Mod.	Bad
Good	2	0	0
Mod.	0	0	0
Bad	0	0	0

Humerus—Upper Epiphysis.

I. NON-OPERATIVE.

Cases: 5

Functional.

Anatomical.	Good	Mod.	Bad
Good	4	0	0
Mod.	0	0	0
Bad	1	0	0

II. OPERATIVE.

Class A.

Cases: 2.

Functional.

Anatomical.	Good	Mod.	Bad
Good	2	0	0
Mod.	0	0	0
Bad	0	0	0

Classes B and C. = 0.

Humerus—Fracture of Tuberosity.

I. NON-OPERATIVE.

Cases: 3.

Functional.

Anatomical.	Good	Mod.	Bad
Good		0	0
Mod.	0	2	0
Bad	0	0	0

Humerus—Surgical Neck.

I. NON-OPERATIVE.

Cases: 40.

Functional.

Anatomical.	Good	Mod.	Bad
Good	18	4	0
Mod.	6	3	2
Bad	1	0	6

II. OPERATIVE.

Class A.

Cases: 6.

Functional.

Anatomical.	Good	Mod.	Bad
Good	4	0	0
Mod.	0	1	0
Bad	0	0	1

Classes B. and C.

Cases: 7.

Functional.

Anatomical.	Good	Mod.	Bad
Good	6	0	0
Mod.	1	0	0
Bad	0	0	0

Humerus—Shaft.

NON-OPERATIVE.

Cases: 73.

Functional.

Anatomical.	Good	Mod.	Bad
Good	44	3	0
Mod.	14	5	0
Bad	2	4	1

II. Operative.

Class A.

Cases 6.

Functional.

Anatomical.	Good.	Mod.	Bad.
Good	5	1	0
Mod.	0	0	0
Bad	0	0	0

Classes B. and C.

Cases: 13.

Functional.

Anatomical.	Good	Mod.	Bad.
Good	7	2	1
Mod.	1	0	1
Bad.	0	0	1

Humerus.—Supra-condylic.

I. Non-Operative.

Cases: 18.

Functional.

Anatomical.	Good	Mod.	Bad
Good	7	0	0
Mod.	2	5	1
Bad	0	0	3

II. Operative.

Class A.

Cases: 1.

Mod. anatomical with good functional result.

Classes B. *and* C.

Cases: 6.

Functional.

Anatomical.	Good	Mod.	Bad
Good	1	2	0
Mod.	0	0	0
Bad	1	1	1

Humerus—Lower Epiphysis.

I. Non-Operative.

Cases 59.

Functional.

Anatomical.	Good	Mod.	Bad
Good	26	0	0
Mod.	10	5	0
Bad	3	5	10

II. Operative.

Class A.

Cases: 14.

Functional.

Anatomical.	Good	Mod.	Bad
Good	8	1	0
Mod.	0	2	0
Bad	1	1	1

Classes B. and C.

Cases: 6.

Functional.

Anatomical.	Good	Mod.	Bad
Good	1	0	0
Mod.	0	2	0
Bad	0	1	2

Humerus—Capitellum.

I. Non-Operative.

No cases.

II. Operative.

Class A.

Cases: 1.

Mod. anatomical with good functional result.

Humerus—Internal Condyle.

I. Non-Operative.

Cases: 17.

Functional.

Anatomical.	Good	Mod.	Bad
Good	7	2	0
Mod.	3	2	0
Bad	1	0	2

II. OPERATIVE.

Class A.

No Cases.

Class B.

1 *Case*: Mod.—Mod.

Humerus—Ext. Condyle.

I. NON-OPERATIVE.

Cases: 7.

Functional.

Anatomical.	Good.	Mod.	Bad
Good	1	0	0
Mod.	3	3	0
Bad	0	0	0

II. OPERATIVE.

No Cases.

Radius—Upper Epiphysis.

I. NON-OPERATIVE.

Cases: 2.

Functional.

Anatomical.	Good	Mod.	Bad
Good	1	0	0
Mod.	0	1	0
Bad	0	0	0

II. OPERATIVE.

No Cases.

Radius—Shaft.

I. NON-OPERATIVE.

Cases: 47.

Functional.

Anatomical.	Good	Mod.	Bad
Good	25	3	0
Mod.	4	7	0
Bad	2	2	4

II. OPERATIVE.

Class A.

Cases: 7.

Functional.

Anatomical.	Good	Mod.	Bad
Good	4	0	0
Mod.	1	0	1
Bad	0	0	1

Classes B. & C.

Cases: 7.

Functional.

Anatomical.	Good	Mod.	Bad
Good	0	0	0
Mod.	1	2	0
Bad	2	1	1

Radius—Lower Epiph.

I. NON-OPERATIVE.

Cases: 15.

Functional.

Anatomical.	Good	Mod.	Bad
Good	10	1	0
Mod.	1	2	0
Bad	1	0	0

II. OPERATIVE.

Class A.

1 *Case*: Good—Good.

Classes B. and C.

Cases: 0.

Ulna—Olecranon.

I. NON-OPERATIVE.

Cases: 20.

Functional.

Anatomical.	Good	Mod.	Bad
Good	9	1	0
Mod.	6	1	1
Bad	0	1	1

II. Operative.

Class A.

Cases: 19.

Functional.

Anatomical.	Good	Mod.	Bad
Good	14	3	0
Mod.	1	1	0
Bad	0	0	0

Classes B. and C.

Cases: 19.

Functional.

Anatomical.	Good	Mod.	Bad
Good	12	3	1
Mod.	0	0	1
Bad	0	0	2

Ulna.—Shaft.

I. Non-Operative.

Cases: 18.

Functional.

Anatomical.	Good.	Mod.	Bad.
Good	14	1	0
Mod.	1	1	0
Bad	1	0	0

II. Operative.

Class A.

1 Case: Bad Anatomical—Mod. Functional.

Classes B and C.

Cases: 4.

Functional.

Anatomical.	Good.	Mod.	Bad.
Good	0	0	0
Mod.	1	0	1
Bad	0	1	1

Ulna.—Lower Epiphysis.

I. Non-Operative.

Cases: 2.

Both Good—Good.

II. Operative.

Cases: 0.

Radius and Ulna—Shafts.

I. Non-Operative.

Cases: 76.

Functional.

Anatomical.	Good.	Mod.	Bad.
Good	29	8	0
Mod.	11	12	3
Bad	2	4	7

II. Operative.

Class A.

Cases: 8.

Functional.

Anatomical.	Good.	Mod.	Bad.
Good	6	0	0
Mod.	0	2	0
Bad	0	0	0

Classes B. *and* C,

Cases: 13.

Functional.

Anatomical.	Good.	Mod.	Bad.
Good	0	1	0
Mod.	3	1	0
Bad	0	2	6

Colles's Fracture.

I. Non-Operative.

Cases: 47.

Functional.

Anatomical.	Good.	Mod.	Bad.
Good	13	0	0
Mod.	11	11	3
Bad	3	5	1

II. OPERATIVE.

Class A.

Cases: 1.

Good anatomical, good functional result.

Class C.

Cases: 1.

Good anatomical with moderate functiona result.

3. The answers to the four following questions appear to the Committee to afford in a compact form the most important information with reference to the result of treatment of any given fracture :—

(i.) Of a given method, what is the percentage of good result—*i.e.*, a good anatomical combined with a good functional result?

(ii.) Of a given method, what percentage of results are bad both anatomically and functionally?

(iii.) What is the frequency of a good functional result when the anatomical result is defective?

(iv.) What is the frequency of an imperfect functional result if the anatomical result be bad?

The answers to these questions are given in Table III., which shows in four columns the number of each fracture which were reported as (1) good anatomically and functionally; (2) Bad anatomically and functionally; (3) Defective anatomically but good functionally; (4) Good anatomically but defective functionally.

If desired, further statistics can be compiled from the squares given above.

TABLE III.

I. Non-Operative.

(I.) LOWER EXTREMITY.

FRACTURE.	No. of Cases.	Good Anat. Good Funct.	Bad Anat. Bad Funct.	Mod. or Bad Anat. Good Funct.	Good Anat. Mod. or Bad Funct.
FEMUR—					
Neck	91	15	26	9	3
Epiphysis of head ..	9	4	1	2	0
Shaft—Upper ⅓ ..	96	52	12	16	1
,, Middle ⅓ ..	438	297	16	67	17
,, Lower ⅓ ..	104	61	7	16	2
Lower extremity .. (involving knee-joint)	12	5	3	1	0
Lower Epiphysis ..	9	5	0	1	2
TIBIA—					
Shaft	426	317	10	46	20
Lower Epiphysis ..	3	3	0	0	0
Inter. malleolus ..	2	1	0	0	0
FIBULA—					
Shaft	153	108	6	6	19
Ext. malleolus ..	2	2	0	0	0
TIBIA AND FIBULA—					
Shafts	549	244	31	141	19
Pott's	248	93	22	26	32
TOTALS ..	2142	1207	134	331	115
		56·3%	6·2%	15·4%	5·3%

(ii.) UPPER EXTREMITY.

FRACTURE.	No. of Cases.	Good Anat. Good Funct.	Bad Anat. Bad Funct.	Mod. or Bad Anat. Good Funct.	Good Anat. Mod. or Bad Funct.
HUMERUS—					
Anat. Neck	5	4	1	0	0
Upper Epiphysis ..	5	4	0	1	0
Tuberosity	3	1	0	0	0
Surg. Neck	40	18	6	7	4
Shaft	73	44	1	16	3
Supra-condylic ..	18	7	3	2	0
Lower Epiphysis ..	59	26	10	13	0
Int. Condyle	17	7	2	4	2
Ext. Condyle	7	1	0	3	0
RADIUS—					
Upper Epiphysis ..	2	1	0	0	0
Shaft	47	25	4	6	3
Lower Epiphysis ..	15	10	0	2	1
ULNA—					
Olecranon	20	9	1	6	1
Shaft	18	14	0	2	1
Lower Epiphysis ..	2	2	0	0	0
RADIUS AND ULNA—					
Shafts	76	29	7	13	8
Colles's	47	13	1	14	0
TOTALS ..	454	215	36	89	23
		=47·3%	=7·9%	17·4%	5·0%

II. Operative.

CLASS A.

(i.) Lower Extremity.

FRACTURE.	No. of Cases.	Good Anat. Good Funct.	Bad Anat. Bad Funct.	Mod. or Bad. Anat. Good Funct.	Good Anat. Mod. or Bad Funct.
FEMUR—					
Neck	1	1	0	0	0
Upper ⅓	3	3	0	0	0
Middle ⅓	27	25	0	0	0
Lower ⅓	2	1	0	0	0
Lower extremity involving joint ..	1	1	0	0	0
TIBIA—					
Shaft	17	13	0	3	0
FIBULA—					
Shaft	1	1	0	0	0
TIBIA AND FIBULA—					
Shafts	22	14	2	1	3
Pott's	4	2	0	0	1
TOTAL ..	78	61	2	4	4
		=78·2%	=2·5%	=5·0%	=5·0%

(ii.) UPPER EXTREMITY.

FRACTURES.	No. of Cases.	Good Anat. Good Funct.	Bad Anat. Bad Funct.	Mod. or Bad Anat. Good Funct.	Good Anat. Mod. or Bad Funct.
HUMERUS—					
Anat. Neck	2	2	0	0	0
Upper Epiphysis ..	2	2	0	0	0
Surg. Neck	6	4	1	0	0
Shaft	6	5	0	0	1
Capitellum	1	0	0	1	0
Lower Epiphysis ..	14	8	1	1	1
Supra-condylic ..	1	0	0	1	0
RADIUS—					
Shaft	7	4	1	1	0
Lower Epiphysis ..	1	1	0	0	0
ULNA—					
Olecranon	19	14	0	1	3
Shaft	1	0	0	0	0
RADIUS AND ULNA—					
Shafts	8	6	0	0	0
Cólles's	1	1	0	0	0
TOTALS ..	69	47 =68·1%	3 =4·3%	5 =7·2%	5 =7·2%

Class B.

LOWER AND UPPER EXTREMITY.

FRACTURES.	No. of Cases.	Good Anat. Good Funct.	Bad Anat. Bad Funct.	Mod. or Bad Anat. Good Funct.	Good Anat. Mod. or Bad Funct.
FEMUR—					
Neck	1	0	0	0	0
Upper ⅓	1	1	0	0	0
Middle ⅓	10	6	1	0	0
Lower ⅓	2	0	0	1	1
Lower extremity involving knee joint	3	0	2	0	0
TIBIA—					
Shaft	2	0	0	1	0
TIBIA AND FIBULA—					
Shafts	18	3	2	9	1
Pott's	2	1	0	0	0
HUMERUS—					
Surg. Neck	4	4	0	0	0
Shaft	7	6	1	0	0
Supra-condylic ..	5	1	1	1	1
Lower Epiphysis ..	3	1	1	0	0
Inter. condyle ..	1	0	0	0	0
ULNA—					
Olecranon	12	9	0	0	3
Shaft	2	0	0	0	0
RADIUS—					
Shaft	2	0	0	2	0
RADIUS AND ULNA—					
Shafts	3	0	1	1	0
TOTALS ..	78	32	8	15	6

Class C.

LOWER AND UPPER EXTREMITIES.

FRACTURES.	No of Cases.	Good Anat. Good Funct.	Bad Anat. Bad Funct.	Mod. or Bad Anat. Good Funct.	Good Anat. Mod. or Bad Funct.
FEMUR—					
Upper ⅓	7	0	5	2	0
Middle ⅓	9	4	2	3	0
Lower ⅓	4	0	1	1	1
Lower Epiphysis ..	1	0	1	0	0
Lower Extremity involving knee joint	2	0	1	0	0
TIBIA—					
Shaft	1	1	0	0	0
TIBIA AND FIBULA—					
Shafts	17	4	4	5	0
Pott's	4	0	3	0	0
HUMERUS—					
Surg. Neck	3	2	0	1	0
Shaft	6	1	1	1	3
Supra-condylic ..	1	0	0	0	1
Lower Epiphysis ..	3	0	1	0	0
ULNA—					
Olecranon	7	3	2	0	1
Shaft	2	0	1	1	0
RADIUS—					
Shaft	5	0	1	1	0
RADIUS AND ULNA—					
Shafts	10	0	5	2	1
Colles's	1	0	0	0	0
TOTALS ..	83	15	28	17	7

An analysis of all the results, non-operative and operative, clearly shows the interdependence of the anatomical and functional result. The total number of cases in which a good anatomical result was obtained is 1,736, and in no less than 1,576 of these the functional result was also good.

In other words :—

If the anatomical result be good the functional result is good in 90.7 per cent.

If the anatomical result be moderate or bad, the functional result is good in 380 out of 1,279—*i.e.*, 29.7 per cent.

If the anatomical result be bad, the functional result is bad in 176 out of 330—*i.e.*, 53.3 per cent.

4. In Table IV. are compared the results of operative and non-operative treatment.

TABLE IV.

Comparison of the results of Non-Operative and Operative Treatment.

I. NON-OPERATIVE.

No. of Cases.	Good Anat. Good Funct.	Bad Anat. Bad Funct.	Mod. or Bad Anat. Good Funct.	Good Anat. Mod. or Bad Funct.
2596	1422 = 54·3%	169 = 6·5%	419 = 16·1%	138 = 5·3%

II. OPERATIVE.

(i.) Class A.

No. of Cases.	Good Anat. Good Funct.	Bad Anat. Bad Funct.	Mod. or Bad Anat. Good Funct.	Good Anat. Mod. or Bad Funct.
147	108 = 73·4%	5 = 3·4%	9 = 6·1%	9 = 6·1%

(ii.) Class B.

No. of Cases.	Good Anat. Good Funct.	Bad Anat. Bad Funct.	Mod. or Bad Anat. Good Funct.	Good Anat. Mod. or Bad Funct.
78	32 = 41·0%	8 = 10·2%	15 = 19·2%	6 = 7·6%

(iii.) Class C.

No. of Cases.	Good Anat. Good Funct.	Bad Anat. Bad Funct.	Mod. or Bad Anat. Good Funct.	Good Anat. Mod. or Bad Funct.
83	15 = 18·0%	28 = 33·7%	17 = 20·4%	7 = 8·4%

The figures in 1st and 3rd Columns added together give the number of Cases in which a good functional result was obtained.

In considering both the non-operative and operative results it must be borne in mind that the methods employed varied greatly, and also that the operative treatment of fractures is as yet in its infancy. There is reason to suggest that as operative treatment is more extensively used, and if in such operations the less efficient methods of fixing the fragments are discarded, the results will show a considerable improvement on those above. Non-operative treatment, on the other hand, is thoroughly established; though it must be admitted that some recent modifications have been introduced, but not yet extensively used, so that judgment on the results would be somewhat premature.

5.—AGE GROUPS.

While the early analysis was based on the age groups defined in paragraph 11, it was found that for all practical purposes age groups might be condensed into children (0-15), and adult life (over 15).

An attempt has been made, on this basis, to determine the influence of age on the result of treatment.

TABLE V.

I. NON-OPERATIVE.

Under 15: 1,016 cases. Good functional result in 90·8 per cent.

Over 15: 1,580 cases Good functional result in 45·4 per cent.

II. OPERATIVE (Class A).

Under 15: 64 cases. Good functional result in 93·6 per cent.

Over 15: 83 cases. Good functional result in 66·3 per cent.

In Table VI., three fractures are taken, and the percentages of good functional results (leaving the anatomical result out of consideration) are given for each age group.

In each succeeding age group the proportion of good results is smaller than in the preceding age group.

Analysis of the cases under age groups makes it clear that there is a progressive depreciation of the functional result of non-operative treatment as age advances; in other words, the older the patient the worse the result.

TABLE VI.

PERCENTAGES OF GOOD FUNCTIONAL RESULTS FOR EACH AGE GROUP (3 FRACTURES).

TIBIA AND FIBULA.—SHAFTS.	
0-10	93 per cent.
11-15	95 ,,
16-20	81 ,,
21-25	77 ,,
26-45	65 ,,
46-60	57 ,,
61–	50 ,,
RADIUS AND ULNA.—SHAFTS.	
0-10	72 per cent.
11-15	52 ,,
16-20	50 ,,
21-25	50 ,,
26-45	28 ,,
46-60	28 ,,
POTT'S.	
0-10	100 per cent.
11-15	100 ,,
16-20	50 ,,
21-25	54 ,,
26-45	54 ,,
46-60	38 ,,
61–	30 ,,

6. PERIOD OF INCAPACITATION.

As already pointed out, the details as to the period of incapacitation are available only in a small proportion of the cases. The result of this is that while the non-operative material is sufficiently large to yield a fairly reliable numerical value for the average length of convalescence—the operative is so small that no corresponding figure of any value can be obtained. The results of the analysis of the material available are set out in Table VII. This Table shows, for each group of fractures (a) the number of cases in which the period of incapacitation was stated; (b) the average duration in weeks of incapacitation; (c) the number of cases in which incapacitation was permanent.

The cases are grouped into :—I. Non-Operative; II. Operative. Each of these groups being divided into: (i.) Cases under 15 years of age; (ii.) Cases over 15 years of age.

TABLE VII.

AVERAGE DURATION OF INCAPACITATION.

I. Non-Operative.

(i.) UNDER 15 YEARS.

FRACTURE.	No. of cases in which period of incapacitation was stated.	Average number of weeks of incapacitation.	No. of cases in which incapacitation was permanent.
HUMERUS—			
Anatomical Neck / Upper Epiphysis	1	8	—
Surgical Neck / Shaft	23	10·5	—
Lower Epiphysis / Supra-condylic	48	13·5	—
RADIUS AND ULNA	73	17·1	—
COLLES'S FRACTURE	4	3·7	—
FEMUR—			
Neck / Upper Epiphysis	7	26·5	—
Shaft	196	16·5	—
Lower Extremity / Lower Epiphysis	8	18·2	—
TIBIA AND FIBULA—			
Shafts	219	12·8	1
Lower Epiphysis / Pott's Fracture	11	22	—
Total	599	14·7	1

I. Non-Operative.

(ii.) Over 15 Years.

Fracture.	No. of cases in which period of incapacitation was stated.	Average number of weeks of incapacitation.	No. of cases in which incapacitation was permanent.
Humerus—			
Anatomical Neck, Upper Epiphysis	5	5·2	1=20%
Shaft, Surgical Neck	70	27·6	7=10%
Lower Epiphysis, Supra-condylic	17	17·1	2=17%
Radius and Ulna	64	20·6	4=6·2%
Colles's	34	17·1	5=14·7%
Femur—			
Neck, Upper Epiphysis	65	53·2	20=30·7%
Shaft	179	33·6	21=11·7%
Lower Epiphysis, Lower Extremity	8	18·7	2=25%
Tibia and Fibula—			
Shafts	673	26·7	41=3·1%
Epiphysis, Pott's Fracture	209	23·7	17=6%
Totals	1,324	27·6	121=9·0%

II. Operative.

(Class A.)

(i.) Under 15 Years.

Fracture.	No. of cases in which period of incapacitation was stated.	Average number of weeks of incapacitation.	No. of cases in which incapacitation was permanent.
Humerus—			
Surgical Neck, Shaft	1	26	—
Supra-condylic, Lower Epiphysis	4	8·7	—
Ulna and Radius—			
Both Bones and Epiphysis	1	6	—
Femur—			
Shaft	4	16·2	—
Tibia and Fibula—			
Shaft	3	9	—
Total	13	12·2	—

II. Operative.

(Class A.)

(ii.) Over 15 Years.

Fracture.	No. of cases in which period of incapacitation was stated.	Average number of weeks of incapacitation.	No. of cases in which incapacitation was permanent.
Humerus—			
Anatomical Neck, Surgical Neck, Upper Epiphysis	1	8	—
Surgical Neck, Shaft	9	32·8	—
Supra-condylic, Lower Epiphysis	1	78	—
Ulna and Radius—			
Both Bones, Lower Epiphysis	25	19·4	2 = 8 %
Colles's	1	—	1 = 100 %
Femur—			
Shaft	2	52	—
Femur—			
Lower Extremity, Lower Epiphysis	1	26	—
Tibia and Fibula—			
Shafts	22	31·2	2 = 9 %
Pott's and Lower Epiphysis	2	14·5	—
Total	64	27·3	5= 7·8 %

SUMMARY OF TABLE VII.

All Fractures over 15 Years of Age.

	No. of Cases.	Average duration of incapacitation.	No. of Cases in which incapacitation was permanent.
I. Non-operative	1,324	27·6	121 = 9·0 %
II. Operative	64	27·3	5 = 7·8 %

It is clear that some of the cases in Class B, and all of the cases in Class C are really failures of non-operative treatment, and might reasonably be included in the non-operative cases. For the sake of completeness the cases in Class C are tabulated in Table VIII.

In Table IX the cases in Class C are added to the non-operative, and the average duration of incapacitation given for these two classes.

TABLE VIII.

II. Operative.

(Class C.)

(ii.) Over 15 Years.

Fracture.	No. of cases in which period of incapacitation was stated.	Average number of weeks of incapacitation.	No. of cases in which incapacitation was permanent.
Humerus	6	81·0	—
Radius and Ulna	16	54·4	1=6·2%
Colles	1	48·0	—
Femur—			
Shaft	9	71·2	4=44·4%
Lower extremity involving knee-joint and Lower Epiphysis	2	291·0	—
Tibia and Fibula—			
Shafts		49·2	3=20·0%
Pott's	2	208	—
Total	51	76·6	8=15·6%

TABLE IX.

AVERAGE DURATION OF INCAPACITATION.

All Fractures over 15, Non-Operative, and Operative Class C.

No. of cases.	Average duration of incapacitation—weeks.	No. of cases in which incapacitation was permanent.
1375	29·3	129 = 10·0 %.

7.—FATAL CASES.

In Table X. is given the total number of cases of fractures of the long bones treated during the selected years, at the Hospitals in which cases were investigated.

From the following Hospitals statistics as to mortality rate were not obtained:—

Dublin—Adelaide Hospital, Mercer's Hospital. Glasgow—Victoria Infirmary. London—Metropolitan Hospital.

TABLE X.

	Hospital.	Cases Treated Non-operatively.		Cases Treated Operatively.	
		Recovered.	Died.	Recovered.	Died.
	1	576	7	13	0
	2	75	4	38	1
	3	1239	22	334	3
	4	100	2	51	1
	5	1459	8	121	0
	6	981	9	46	0
	7	4	0	50	0
	8	632	10	23	0
	9	149	0	17	0
	10	1359	14	69	1
	11	448	4	42	0
	12	89	2	12	0
	13	2234	7	32	1
	14	934	6	124	1
	15	1667	34	68	0
Totals ..	—	11946	129=1·0%	1040	8=0·77%

This Table shews that in 15 of the 19 Hospitals in which an investigation was held 11,946 fractures of the long bones were treated non-operatively, of which 129 had a fatal result, a mortality rate of 1·0 per cent.: the majority of deaths were due either to age, disease, or associated injuries.

1,040 cases were treated by operation, and of these a fatal result ensued in 8 cases, a mortality rate of 0·77 per cent.

The causes which in the non-operatively treated cases led to a fatal result, had a similar result in 5 of the cases treated operatively. The mortality rate, therefore, which may be attributed directly to operation is 0·3 per cent.

Among the operative cases there were three deaths directly attributable to the operation. These were due respectively to septicæmia (2 cases) and sepsis (1 case). According to the Hospital records the remainder were due either to existing organic disease (3 cases) or directly due to the anæsthetic (2 cases).

These two latter should not be attributed to operation, seeing that anæsthetics are employed so extensively in the non-operative treatment of fractures.

It is interesting to note that of the fatal operative cases, no less than 6 were operations undertaken after failure of non-operative treatment (Class C).

From which it is clear that the mortality rate of immediate operation (Class A) is exceedingly small.

Of the two fatal cases in Class A, one was that of a fractured femur associated with a ruptured femoral artery and a wounded femoral vein, in which gangrene resulted after a primary operation (wiring the femur) had been performed.

The second was a case of delayed chloroform poisoning, after an immediate operation for fracture of the humerus in a child.

APPENDICES.

APPENDIX (A).

(1)—ENQUIRY FORM.*

Case No.†.....

(†This No. will be filled in afterwards by the Committee.)

General result, defined as :—

	Good.	Moderate.	Bad.
Anatomical			
Functional			

BRITISH MEDICAL ASSOCIATION.

FRACTURES COMMITTEE.
[Private and Confidential.]

(1)
Bone .....

(2)
Treatment .....

Hospital at which treated (if any).....

Visit : Date .....191.....

Initials of Committee's Investigator .....

NOTE.—For meaning of Nos. (1), (2), (3), &c. see instructions to Investigators printed on separate sheet.

(Please write distinctly.)

Patient's Name.....

Address.....

Age.....years. Sex.....Occupation.....

(3)
Accident: Date.....19..... Nature of force.....

Fracture: Site.....

.....

(4)
Form .....

.....

(5)
Associated injuries.....

.....

.....

(6)
Treatment.....

.....weeks.

.....

.....

* With a view to saving space, the Enquiry Form used by the Committee is here reproduced in a diminished size, and not in the form in which actually used.

.....
.....
.....
.....

Duration of stay in Hospital.....weeks.

Duration of absence from work.....weeks.

Special circumstances influencing treatment and result (7).....
.....
.....
.....
.....

Skiagram :—Before treatment.....

After treatment.....

Results :

(A) Present condition of limb :

(*a*) Nature of Union.....
.....

(*b*) Deformity .....
.....
.....

(*c*) Movement of joints .....
.....
.....

(*d*) Mechanical or pathological changes in joints.....
.....
.....

(*e*) Swelling of soft parts .....
.....

(*f*) Circulation.....
.....

(*g*) Pain.....
.....

(*h*) Changes in muscles :—wasting.....

power.....

(*i*) Nerve phenomena.....
.....

(B) Present wage-earning capacity compared with former.....
.....

(C) If fatal, cause and date of death.....
.....

---

(2)—INSTRUCTIONS OF THE FRACTURES COMMITTEE AS TO THE DETAILED INVESTIGATION OF THE CASES.

(I.) GENERAL INSTRUCTIONS AS TO THE DETAILED INVESTIGATION OF THE CASES.

(*a*) The sole object of the enquiry is to determine the relative advantages of the operative and of the non-operative treatment of fractures.

(*b*) The scope of the enquiry is limited to simple complete fractures of the principal long bones, viz., femur, tibia, fibula, humerus, radius and ulna, and is to include simple separations of the epiphyses of these bones.

(*c*) It is proposed to draw conclusions from those cases only of which full details of the injury, of the treatment, and of the final result can be obtained. For convenience in the conduct of the enquiry, investigation will be limited to cases in which the accident causing the fracture has occurred, or in which an operation has been performed, within the Years 1906-10 inclusive.

(*d*) The Committee desires it to be understood that such material as is placed at its disposal will be used for statistical purposes only, and that no results will be published in such a way as to lead to the identification of the source of any particular contribution.

(II.) SPECIAL INSTRUCTIONS AS TO THE DETAILED INVESTIGATION OF THE CASES.

Summary of Total Cases treated within the Period 1906-10 inclusive (Form "(8)").

(*e*) The Investigator will please see that the Summary of total cases treated within the Period 1906-10 inclusive is filled in by the Surgical Registrar or House Surgeon (irrespective of whether there were, or were not, any cases fatal during treatment within the Period).

Remarks on filling up Enquiry Form (Form "(6.)")

(A specimen filled-up Enquiry Form is enclosed herewith. (Form "(7).")

(*f*) It is particularly requested that all the spaces for answers be filled in, including summary of general result at top of front page of Inquiry Form. If in any instance information is not available, this fact should be stated.

(*g*) All statements embodying a judgment upon the final result of any given case are to be made only by the Investigator specially appointed by the Committee to report upon the case.

(*h*) The special Enquiry Form (marked "(6), Fatal case") should be filled in with reference to *every* case within the Period fatal during treatment, non-operative or operative. The Investigator will satisfy himself as to the cause of death in each such fatal case and enter it in the appropriate space on the front page of the Form.

(*i*) *Notes upon Headings in Enquiry Form.*

(1) (Bone).
Simultaneous fractures of different bones occurring in the same patient are to be reported on separate Forms, except in the case of double fractures commonly associated, viz: those of the tibia and fibula, or of the radius and ulna. State which side.

(2) (Treatment).
Non-operative, operative, or whether operation was undertaken after failure of non-operative treatment.

(3) (Nature of force).
Direct or indirect.

(4) (Form).
Single or multiple; comminuted or linear; transverse, oblique, spiral or T-shaped; free or impacted.

(5) (Associated injuries).

(*a*) Remote: any important lesion elsewhere, affecting treatment.

(*b*) Local: extensive bruising, injury to vessels, nerves or muscles: effusion into joints.

(6) (Treatment).
Nature, and duration in weeks, of each form of treatment used, should be stated.

(7) (Special circumstances influencing treatment and result).
Favourable or unfavourable temperament or physique; pre-existing or intercurrent disease. State reasons for choice of treatment.

(8) (Skiagram: before treatment, after treatment).
State whether the diagnosis, treatment and estimate of result have been controlled by X-rays.

APPENDIX (B),

(*a*) NON-OPERATIVE.

Fracture.....; **Sex**.....; **Age-Group**.....

No. of Enquiry Form.	Age (years.)	Complications.	Anatomical Result.			Functional Result.			Duration of Absence from Work (weeks).
			Good.	Mod.	Bad.	Good.	Mod.	Bad.	
		Totals							Average:

(Note.—The actual form provided space for 20 cases).

(*b*) OPERATIVE.

Fracture.....; **Sex**.....; **Age-Group**.....

No. of Enquiry Form.	Age (years.)	Complications.	Anatomical Result.			Functional Result.			Duration of Absence from Work (weeks).
			Good.	Mod.	Bad.	Good.	Mod.	Bad.	
		Totals							Average:

(Note.—The actual form provided space for 20 cases).

APPENDIX (C).

THE OPERATIVE TREATMENT OF FRACTURES.

Précis of Technique.

By Mons. A. Lambotte, Antwerp.

(With Special Plate.)

The treatment of fractures ought to be guided by two fundamental rules:—

1. To renew the anatomical form of the fractured bone.
2. To move at once the articulations to avoid articular stiffness and atrophy.

The integral anatomical re-constitution is of the highest importance, especially in the adult, in whom the articular surfaces cannot be altered. A good functional condition can be observed with a marked notable deformity, but these cases are the exceptions, and it is unquestionable that the slightest alteration in the shape of the bone leads to definite functional symptoms or permanent pains. The usefulness of movement from the commencement is equally important and is admitted by everyone.

Operative treatment alone fulfils individually and conjointly both these indications in nearly all cases. Theoretically, any fracture being exactly and aseptically reduced ought to heal both readily and perfectly as a simple sub-periosteal fissure (greenstick); what practice confirms in all points.

The technique of osteosynthesis in recent fractures requires two principal points: Reduction and Fixation.

In old fractures these two are preceded by resection of the neck (osseous or fibrous) and the preparation of the ends.

To obtain correct apposition, it is absolutely necessary to possess an appropriate set of instruments. I employ for this operation a whole series of straight and bent forceps provided with teeth. I also utilise some spatulæ and various elevators. For the lower limb a traction apparatus, based on the principle of a lever, allows me to obtain traction of 150 kilogrammes with the hand.

Recent oblique fractures are reduced by longitudinal traction by means of forceps pulling the surfaces to the same level. Transverse fractures are more easily reduced by separating the ends whilst replacing the limb in position (angular replacement of the fragments). With a sufficient armamentarium the

No.	Date of Operation.	Sex and Age.	Lesions.	Operation.	
1	14th Aug., 1902	F. 30	Fracture ⅓ lower end of right femur, exterior over-riding, wound of the left leg, fracture of the left astragulus; bad powers of resistance, fat patient, weight 120 kilogrammes	Sub-cutaneous clamp, osteo-synthesis, with the secondary infection (the patient removed the dressing)	Death after many weeks of deep suppuration.
2	28th Jan., 1903	Girl. 6 days	Obstetrical fracture of the femur, subtrochanteric, enormous over-riding, irreducible	Suture with silver wire	Death from athrepsia on the 8th day; wound united without reaction.
3	25th Sept., 1905	M. 45. Worn-out. Alcoholic	Double fracture of the diaphysis of the femur	Osteo-synthesis with the clamp, six staples	Death 20 days later from multiple haemorrhages; wound in good condition, the lower fracture united, the upper slightly suppurating, Septicæmia (?).
4	May 28th, 1905	M. 45. Alcoholic scoriosis	Old fracture below the head of the femur (3 months), pains, and functional uselessness from pseudo-arthrosis	Reduction of the head of the femur	Death from acute pneumonia in 5 days.
5	July 5th, 1906	M. 18	Fracture of the diaphysis of the femur, transverse with over-riding	Osteo-synthesis with the clamp	Wound healed in 5 weeks. Fracture united. The patient walked with crutches. Sudden death from embolism (?). Nothing on autopsy.
6	Dec. 20th, 1906	F. 72	Fracture below the head of the femur	Screwing of the neck of the femur	Ordinary course for some days, then infection by wetting of the dressing by the urine. Suppuration. Secondary resection of the head and drainage. Death three months later from exhaustion.
7	March 5th, 1907	F. 74	Idem	Idem	Idem, death from slowsepticæmia.
8	Sept. 17th, 1910	M. 36	Old fracture of the femur (3 months) non-united	Reduction and clamp	Result, straightforward union, notwithstanding a slight suppuration. Six weeks later abdominal symptoms (appendicitis or peritonitis), evacuation of pus by the stools. Death from slow infection.
9	June 4th, 1908	M. 50. Cardiac, obese	Dislocation, fracture of the iliac bone (accident on the railway)	Wiring of the pubis	Slow infection and suppuration of the cavity of Retzius. Death in 4 weeks.

reduction, by ordinary manipulation, of *recent simple fractures* never presents any difficulty and always produces accurate apposition. The only difficulties occur with comminuted fractures. The technique of the reduction is here more difficult and varies according to the case; in principle, it is necessary always to endeavour to reduce and fix the intermediate fragment to one of the principal ends and thus change the comminuted fracture to a simple one which is then easily reduced. In old fractures of the diaphysis the difficulty of replacement varies; it is easy with transverse fractures by employing angular replacement; it is more difficult in oblique fractures, these require reduction by direct traction. Reduction obtained by ordinary manipulation ought nearly always to be maintained by *direct fixation.*

In certain jagged fractures, capable of impaction (tibia, radius, ulna) it is sometimes possible to dispense with fixation of the fragments, but these cases represent a minimum number of the fractures. Fixation can only be dispensed with with great caution, if one would avoid painful lack of success. The absence of direct fixation requires besides a fixation bandage which removes one part of the advantages of operation. In the femur and humerus, fixation is advisable in all cases, it is indispensable in all oblique and comminuted fractures.

The fixation apparatus ought to respond to the following conditions:—(a) It should be easily applied, (b) easily removed, and (c) the fragments should be sufficiently firmly fixed so as to dispense with a fixation bandage and permit the play of the neighbouring articulations. The majority of the apparatus recommended for fixation is bad and ought to be abandoned. After having experimented with a great number of them, I only employ two: the hoop and the screw.

The hoop consists of strong metallic wire (soft iron, copper) 1 to 2 mm., and constitutes the ideal method of fixation in oblique fractures of the diaphysis; it is necessary only to have recourse to it when the length of the line of the fracture is equal or superior to twice the diameter bone.

The screw is applied in three ways:—

1. Direct screwing of the fragments (epiphysis).
2. Screwing with plates (prothesis).
3. Screwing with external protector (clamp).

The latter is the best procedure for transverse fractures of the tibia; I have renounced its employment for fractures of the forearm, and it is only exceptionally that I have recourse to it in fractures of the humerus and femur. The thickness of the muscular masses of the arm and thigh lay the latter open to secondary infections.

Screwing with brass plates (prothesis) gives excellent results in the fore-arm, the humerus, and the femur.

Whatever the technique employed, the condition that ought to dominate the whole surgery of fractures is Asepsis. It is necessary to operate with a mask to avoid contamination with the air, and with gloves to avoid infection by contact. It is absolutely necessary to avoid all digital manœuvres in the wound and all contact of the skin with the materials used for the sutures. The preparation of the wound is of great importance; personally I only intervene 8-15 days after the accident (save for special indications). Before the operation I inject nucleinic acid (1.0 centigramme the night before the operation, 5 centigrammes the two days following): I have the impression that this treatment is useful.

In splintering of the bone it is necessary to refrain from extracting and sacrificing the loose fragments. In a third of the cases, above all in the tibia, I have made, more or less, extensive re-implantation of the fragments (once half the length of the fibia, once the internal third of the clavicle). The union of these fragments is certain if the wound remains aseptic. The reposition of the splinters is of great importance because the loss of substance which would result from their removal would be the cause of slowness of union or even pseudo-arthrosis. The danger of operative treatment is slight, if one operates under desirable conditions, it will become absolutely negligible when sufficient practice has been obtained in this branch of surgery. My statistics amount to 567 operations with nine deaths, 1½ per cent.

All the cases of death which I had to deplore concern fractures of the femur and pelvis. Some are not caused by osteo-synthesis. In three cases only septicæmia has followed osteo-synthesis with the clamp. This apparatus presents some danger to the femur. I have also employed it much less in fractures of the leg.

The other mishaps which are attributed to operative treatment are not well founded, when, as goes without saying, the operation has been correctly carried out. All the accidents with which one reproaches osteo-synthesis are only the consequences of infection. These infections are avoidable. They chiefly are produced in operations badly and slowly carried out, or the fragments are manipulated for too long a time. Asepsis in the surgery of fractures is only obtainable with a clean technique permitting of a quick and certain operation.

APPENDIX (D).

ANALYSIS OF CASES TREATED BY MONS. A. LAMBOTTE, OF ANTWERP, INVESTIGATED AT ANTWERP.

(*Returns not received in time for inclusion in main Report.*)

(All the cases belonged to Class A.)

LOWER EXTREMITY.

FRACTURE.	No. of Cases.	Good Anat. Good Funct.	Bad Anat. Bad Funct.	Mod. or Bad Anat. Good Funct.	Good Anat. Mod. or Bad Funct.
Femur	13	10	0	0	2
Tibia	5	4	0	1	0
Fibula	1	1	0	0	0
Tibia and Fibula.. ..	18	16	0	1	0
Pott's	1	1	0	0	0
TOTAL	38	32	0	2	2
		64·2%	—	5·2%	5·2%

UPPER EXTREMITY.

FRACTURE.	No. of Cases.	Good Anat. Good Funct.	Bad Anat. Bad Funct.	Mod. or Bad Anat. Good Funct.	Good Anat. Mod. or Bad Funct.
Humerus	14	8	0	2	2
Radius	1	1	0	0	0
Ulna	1	1	0	0	0
Ulna and Radius ..	5	2	0	0	1
TOTAL	21	12	0	2	3
		57·1%	—	9·5%	14.2%

TABLE IV.

No. of Cases.	Good Anat. Good Funct.	Bad Anat. Bad Funct.	Mod. or Bad Anat Good Funct.	Good Anat. Mod. or Bad Funct.
59	44	0	4	5
	74·5%	—	6·7%	8·4%

APPENDIX (E).

METHOD OF PROCEDURE IN OPERATIONS ON SIMPLE FRACTURES.

By MR. W. ARBUTHNOT LANE, M.S.Lond., F.R.C.S.Eng.

(With Special Plate.)

It is necesssary to take especial precaution to secure asepsis, for the reason that in these operations a foreign body of some considerable size is left in the wound and also because the soft structures are usually lacerated, bruised and inflamed and their resisting power to the entry of organisms is depreciated proportionately to the damage they have sustained. This is particularly the case in fractures produced by direct violence.

Previous to any operative treatment of fractures, satisfactory X-ray photographs of the injured parts are absolutely essential. They should be taken in at least two planes crossing one another at right angles in order that the operator should have the fullest information as to the nature of the fracture and the relationship of the fragments to one another. When it is impossible to obtain photographs in these two planes a stereoscopic arrangement often throws much light on the details required.

The skin should be thoroughly cleaned with ether, benzine, soap and water, and sterilized as far as possible by a suitable germicide. A useful method is to apply biniodide of mercury in methylated spirit first and then to employ tincture of iodine. How the cleaning is done is a detail, but if the epidermal layer is hard and thick it should be effectually removed by hot moist compresses and frequent scraping before any germicide is applied.

The plates used are of strong tough steel and should be carefully tested by the instrument makers before they are employed. Much discredit has arisen from the use of cheap plates which break either during or after the operation. There is no excuse whatever for the use of bad plates. In most cases the plate should be of toughened steel capable of being bent by powerful forceps in order that the plate should fit accurately a curved or variable surface. Sometimes, as in the case of old fractures with considerable overlapping of fragments a rigid plate is better as the bending strain it has to meet may be very great. The longer the plate and the greater the number of the screws the more secure is the hold of the plate on the fragments. It is necessary to have a considerable variety of plates to meet the special requirements of any particular case.

The screws are made up in several gauges and lengths. The gauges which are most useful are 3, 5 and 7, and the sizes $\frac{1}{2}$, $\frac{5}{8}$ and $\frac{3}{4}$ inch. They are so cut that the thread extends to the head, there being no barrel to the screw. The reason of this is that only the proximal layer of compact tissue is engaged by the screw, so doing away with an excess of metal and difficulty of finding the drill hole in the distal layer of compact bone.

There is very little variety in the details of the several fractures, and when the surgeon has acquired a familiarity with their treatment, he soon learns exactly what plate is most serviceable

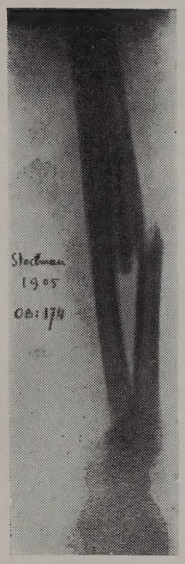
One thing that cannot be impressed too strongly on the surgeon is that he must restore the fragments accurately to their normal relationship before he fastens a plate on to them. The mere fixation of a plate to fragments not in accurate apposition is as foolish as it is painfully frequent at the present time, and the patient is worse than better for the operation even if sepsis is avoided, which unfortunately is too often not the case. The operation is very liable to fall into disrepute because of the incapacity of the operator. There is nothing wrong with the principle, the fault is in its application.

I endeavour to exclude the entry of organisms into the wound, and to minimise damage to soft parts by making an incision *of a length sufficient to allow of free and easy access to the seat of fracture.* The position and length of the incision is a matter of little concern in the case of fractures of the lower extremity, whereas in fractures of the bones of the arm much judgment may be required to avoid damage to nerves and muscles. A sterilised cloth is attached to each edge of the incision by specially constructed forceps in such a way that the surface of the skin of the patient is altogether excluded from view and consequently from the field of operation. All bleeding is controlled by the use of long forceps which are capable of exerting a pressure sufficient to obliterate the lumen of a vessel if left in position a reasonable time, so that it is never necessary to apply ligatures. These forceps, like all instruments used in these operations, are very long in order that the handles shall project beyond the wound area and not touch its surface. In this way the introduction into the wound of the gloved hand or any portion of an instrument which had come into contact with the glove is avoided. This is important since gloves are not absolutely reliable, partly because of the possible presence of punctures and partly because they are liable to be damaged by the use of the heavy instruments employed in these operations.

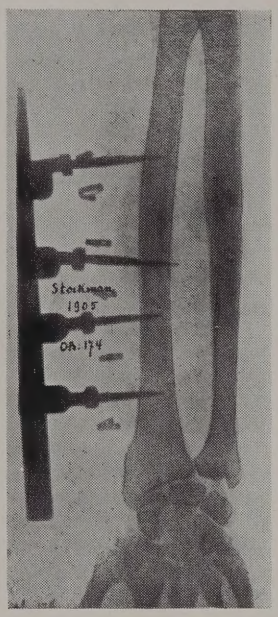
The ends of the broken bone are freely defined, the periosteum being divided and separated, if necessary. A length of each fragment is exposed sufficient to show the whole extent of the fracture and to carry plates long enough to retain the fragments immovably in accurate apposition.

Very little force is requisite to bring the fragments into accurate apposition if proper means be employed to do so. In the case of a fracture by direct injury where there is much

A. LAMBOTTE: OPERATIVE TREATMENT OF FRACTURES.



Fixateur (Lambotte).



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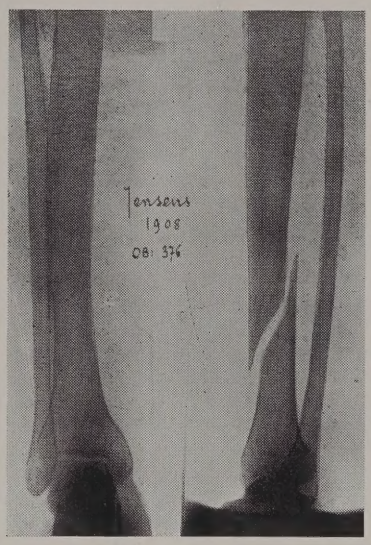
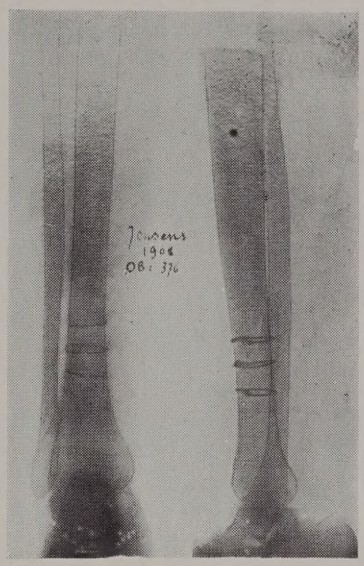
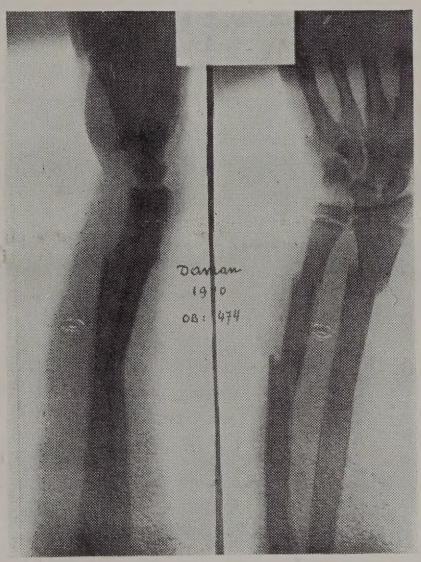


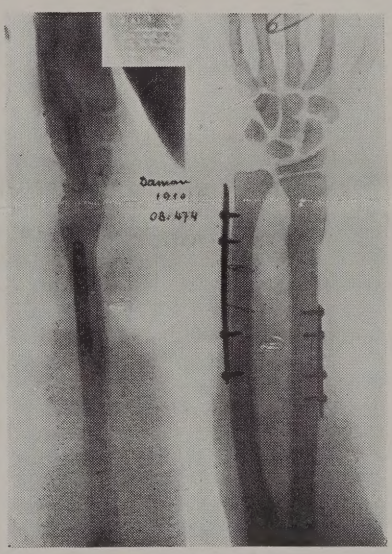
Cerclage (Lambotte).



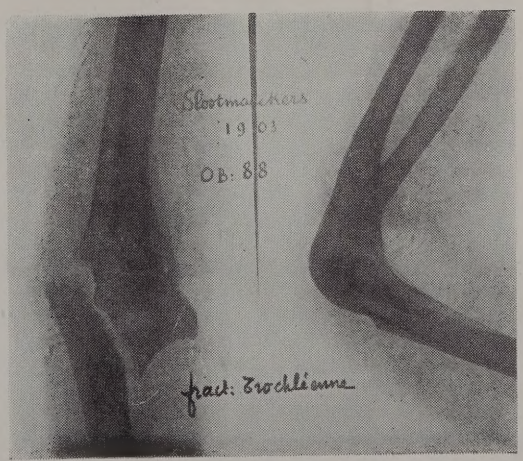
Cerclage (Lambotte)



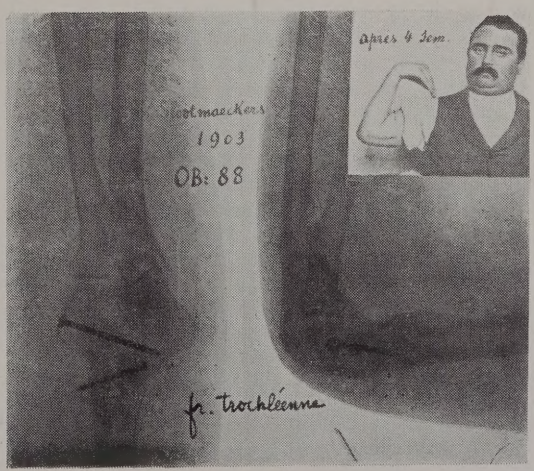
Plates (Lambotte).



Plates (Lambotte).

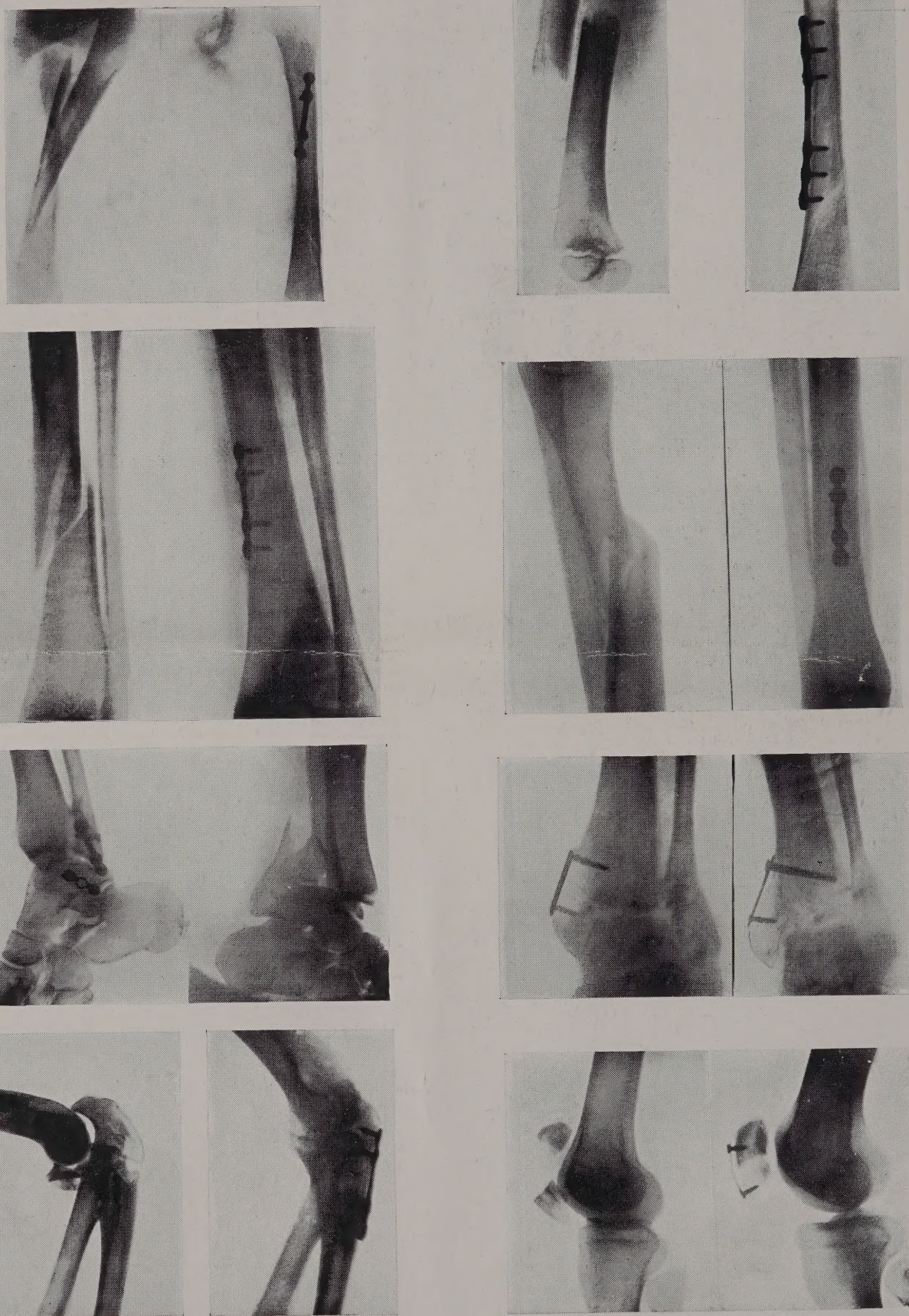


Screws (Lambotte).



Screws (Lambotte).

MR. ARBUTHNOT LANE: PROCEDURE IN OPERATIONS ON SIMPLE FRACTURES.



The photographs are taken before and after operation.

swelling and shortening of the soft parts which form ties in the length of the fractured bone producing considerable overlapping of fragments, a very great amount of traction may have to be exerted upon the fragments before they can be brought into accurate apposition, and during the exercise of this force the wound may become infected. If, on the other hand, the fragments are protruded at a converging angle beyond the wound, each in the grasp of a forceps, their ends may be easily coapted while extending the fragments on one another by straightening the limb beyond the fracture.

Also in the case of a fracture produced by torsion, where the fracture is spiral in character, the fragments may be moved on one another along a double inclined plane by the rotation of powerful forceps, which grasp them, aided sometimes by an elevator which being rotated between the surfaces approximated by the forceps moves them on each other with an irresistible power, the operator expending very little energy in the process. In other words, the accurate coaptation of fragments is brought about by the exercise of manual dexterity rather than by brute force.

If there is a comminution of the fragments the surgeon must meet the difficulty in the best way possible. It is usually effected by fixing a long steel plate securely to the lower fragment and then fastening to the end of that fragment the several smaller pieces in sequence by means of small plates and screws and subsequently securing the upper fragment to the stout steel plate.

(2) In old fractures, especially of the bones of the leg, in which it is important that shortening should be avoided, it is not necessary to cut bone away till large areas of the fragments can be brought into apposition, since a considerable interval left between the fragments will fill up with callus if the part be kept engorged with blood. This is best effected by getting the patient up on crutches, the limb being secured in an apparatus by means of which the weight of the body is transmitted through the tuber ischii to the ground. Except in the case of fracture of the femur I have not considered it advisable to bring the edges of the deep fascia together with sutures. This allows of the free diffusion of blood into the subcutaneous tissue, which picks it up rapidly. Michel's clips form the best medium for retaining the edges of the skin in accurate apposition. The coaptation of the skin edges may be the most difficult part of the operation because of the swelling of the soft parts. It is unwise to place a steel plate directly beneath the skin incision, and wherever possible it is well to bury the plate beneath muscle rather than immediately under the skin. If the latter is done, care should be taken to prevent any prominence of the screws or plate in order to avoid subsequent irritation. Should it be necessary to place a plate beneath the skin where it is liable to be pressed on by a heavy boot, etc., it is sometimes advisable to remove it when it has done its work.

Means should be adopted to prevent fixation of the joints by movements at regular intervals after the operation. This applies particularly to the knee-joint and to the several joints of the foot. The surgeon should bear in mind the necessity of obtaining this movement when he is operating and should not hesitate to put in a very strong plate or plates with enough screws to retain it in position with perfect security.

The only obstacles to operation are excessive comminution or such a fragile condition of the broken bone as renders it incapable of holding screws.

The photographs of cases taken before and after operation will afford the surgeon a better idea of the nature of fractures and the manner in which the fragments can and should be restored to their normal relationship more clearly than any amount of description.

June 22nd, 1912.

APPENDIX (F).

TREATMENT OF FRACTURES BY MASSAGE AND MOBILISATION.

SYNOPSIS OF THE METHOD.

By MONS. J. LUCAS-CHAMPIONNIÈRE, Paris, Member of the Institute.

My principles relative to the treatment of fractures by movement have been published for more than thirty years in numerous works:—through the Society of Surgery, in two large volumes; *Treatment of Fractures by Massage and Mobilisation*, in a bulky volume in 1895; *Summary of Treatment of Fractures by Massage and Mobilisation*, a small volume, in 1910; and *Treatise on Massage of the Limbs*, by Dagron, in 1905.

In English, numerous articles written by me have appeared in the BRITISH MEDICAL JOURNAL; and at New York, in the *Medical News* (January, 1900). I published an important article in the *Medical Annual* of 1909, and made a communication to the meeting of the British Medical Association at Sheffield in 1908. In the *Index of Treatment*, 1908, will be found an important article by Charles Cathcart. Finally, there appeared in 1911 an important volume by Mennel *On Massage and Mobilisation of Fractures*.

It would be premature to write afresh at much length upon the subject. The method, however, is sufficiently well known and established to make it useful to recapitulate its principal conditions by enumerating a series of aphorisms which should constantly guide the surgeon in his practice.

Aphorisms.

A certain amount of movement gives the best condition for the repair of the seats of fractures.

Absolute fixation of the fragments diminishes the production of the reparative elements.

Fixation of the limbs creates conditions which are disastrous to the vitality of the limbs.

It causes bony atrophy, stiffening of the joints and tendinous sheaths, stiffness of the muscles and muscular atrophy. The rapidity of production of these lesions is very great.

The more promptly movement is carried out after the accident the more perfect will be repair, at the same time there being avoided the complications resulting not only from the traumatism but from the traumatism complicated by fixation of the limb.

Fixation, which appears to allay pain, does not allay it permanently, but only temporarily. Immediately the least movement is attempted the pain due to the condition of the fragments and to the lesions of the soft parts caused by the traumatism will be complicated by pains which result from the lesions due to the fixation.

Mobilisation, and especially a certain variety of massage, produce a series of phenomena which are favourable to repair.

At first, anæsthesia, which ought to be the criterion of all treatment by massage.

This massage has immediate and multiple effects, of which the intimate mechanism is difficult to explain, but of which the elementary and physiological effects are easily verified.

Decrease, then disappearance, of pain.

Disappearance of muscular contractions. The result is disappearance of all the deformities resulting from these contractions.

Rapid absorption of blood and serum; disappearance of œdemas and swellings.

Stimulation of secretion of bone; rapidity and solidity of repair of the bone lesion.

Ease and completeness of repair of the torn membranes and muscles; prevention of stiffening and muscular atrophies.

The mode of action of massage is difficult to explain. It cannot be considered as merely the result of the squeezing out of the effused liquids and solids. If it were so, the more violent the massage the more beneficial it would be, while, in fact, its violence precludes almost entirely any benefit from its use.

Its mode of action appears to be extremely complex. It seems to act at one and the same time upon the peripheral nerve endings and upon all the constituent elements of the limb, on which it exercises a direct action.

It must always be practised from the periphery to the centre, that is to say, from the extremities of the limbs towards the centre, in an ascending direction.

It must include an area much more extensive than merely the actual site of the lesion.

Like all anæsthetising or soporific movements of the mesmerist, it must never change its direction. Any pressure the wrong way is productive of pain, in place of giving relief.

Its action is the more favourable the nearer it is employed to the actual time of the traumatism. The longer the pain of the fracture and the contractions have lasted the more difficult will it be to obtain the beneficent effect of the massage.

To obtain such effect in the maximum degree, there must always be observed a graduation which it is impossible to neglect.

Superficial pressures, having almost the form of caresses, should be used at the commencement of all massage, and ought, at the commencement of each future reapplication, to precede the deep pressures and prepare the way for these.

Any recurrence of pain in the course of treatment, or recurrence of pain in the course of the massage itself, calls for a return to superficial pressures.

When massage is associated with mobilisation, mobilisation should not be carried out except after the massage séance. If mobilisation is painful, massage should be resumed before carrying out mobilisation.

For massage, as for mobilisation, it is necessary emphatically to insist upon the important point that "commencement of movement should be as near as possible to the actual time at which the fracture has been produced." Secondary massage and mobilisation are not at all productive of all the benefits secured by immediate movement. Thus, to concede that massage shall be used from the second or third week after the traumatism is entirely to fail to appreciate the method. Such a procedure is a failure to understand the efficacy of the method, and makes certain of its good effect not being obtained. Such a mode of treatment can be advised only by a surgeon who has not understood the mode of action of immediate movement. Even such belated intervention is better than persistent fixation. But this is not the method which we have advocated.

Mobilisation of the limb is not at all the complete re-establishment of the amplitude of its ordinary movements. That amplitude is not directly sought in the manœuvres which accompany and follow bone and joint repair.

The surgeon should aim at the totality, the multiplicity of the movements, *but by degrees*. This multiplicity of movements restricted in their range entirely suffices for the future of the repair. A practice which consists in making as soon as possible the most extensive possible movements is calamitous in the large majority of cases.

Progression in the amplitude of the movements of mobilisation ought to be very slow at first.

Mobilisation should consist at first of passive movements, then of active movements.

As a general rule these active movements should be methodical, carefully-watched, gymnastic movements.

In certain rare circumstances the active movements can from the commencement be functional movements. But this is not the best condition.

As the time of the accident becomes more remote, the functional movements play a more important part in the return of function. But, in many circumstances, they should be carefully directed by the surgeon, who should indicate to the patient which are the movements to avoid and which are those to aim at.

In principle, all fractures can benefit from graduated movement.

In practice, certain fractures urgently require it, and are in fact properly treated only if such movement is carried out. These are, all fractures involving, or in the neighbourhood of, joints.

Only very young subjects can hope for complete restoration after fixation of the sites of articular fractures.

Fractures of the upper extremity of the humerus, fractures of the shoulder in general, fractures of the elbow, fractures of the wrist, fractures in the neighbourhood of the tibio-tarsal joint, fractures of the upper extremity of the femur, these articular fractures derive from the method such a result that their prognosis and treatment are transformed, and that these fractures, formerly very grave in their consequences, can become accidents without importance and without resulting functional alteration.

Certain fractures of the continuity of the bones accompanied by important contractions are amenable to this treatment. Such are the fractures of the clavicle and certain fractures of the humerus.

But the simplest fractures of the continuity of the long bones can, in a great number of cases, benefit by the method, which we have often applied to the middle of the humerus or the middle of the leg.

Experience has shown me the but slight importance, from the point of view of function, of a moderate shortening. I have even been able to demonstrate that this shortening may play a useful part in the phenomena of muscular repair. Thus it is necessary that the surgeon should cease to have in the first rank of his preoccupations the question of shortening and of the complete re-establishment of the length and form of the bone.

One single class of deformity is truly interesting, for the remedy has to cause there, deviation from the axis, even if little marked.

But it must be noted that, thanks to the early disappearance of muscular contractions, these deviations of axis are extremely rare.

If at the time of breaking or impaction the deformity is only a deformity of shortening or of deviation not interfering with function, it creates a circumstance felicitous as regards repair, which will be more rapid and more solid. It is a fortunate condition which should be respected. Forced reduction should be avoided. This is the case of the majority of fractures of the upper extremity of the humerus, of the greater number of fractures of the radius, and of most fractures of the neck of the femur.

The beneficent action of movement on the fractured limb is not only apparent in perfection of function. The first effect appreciated by the patient is the disappearance of pain. Very painful fractures, like those of the shoulder, the elbow, and the neighbourhood of the tibio-tarsus, are a remarkable example of this.

Rapidity of bony repair is abundantly demonstrated.

Solidity of the limb is obtained far more quickly than by means of fixation.

The stimulating effect of massage and movement in the development of callus even requires to be watched. In very young subjects, who secrete bone readily, it should be avoided, in order not to cause formation of excessive callus. Thus, as a principle, infants should not be massaged.

They, however, tolerate very well mobilisation without massage. In their case, massage should be reduced to a sort of superficial caress which suffices for the anæsthetisation of the part.

In all cases, and in conclusion, it must be noted that in this modern treatment of fractures the action of the surgeon by immediate mobilisation and massage is so powerful that it is necessary to watch it closely.

It is certainly of a more delicate application than the treatment by fixation. But its results are so superior to anything that can be achieved by fixation that it should become as generally used as possible.

So applied, it will reduce to an infinitesimal proportion the cases of fractures of which the habitually bad functional results have led surgeons to recommend immediate cutting down upon the seat of fracture. Operations can be had recourse to only in the quite exceptional cases in which the surgeon is reduced to absolute fixation by an insuperable tendency to deformity.

APPENDIX (G).

NAIL EXTENSION FOR FRACTURES.

ACCOUNT OF THE METHOD.

By Dr. F. STEINMANN, Privatdozent der Chirurgie, Bern.

The method of "nail extension" as put forward by me in a publication in the year 1907, is based upon the same principles as is that of continuous adhesive plaster extension, and will, along with the latter method, lead the way in the struggle towards the realisation of a treatment of fractures which aims at a combined anatomical and functional recovery, and by so doing alone makes ideal results possible. Every practitioner will agree with me that in a whole series of fractures he has not attained his object by adhesive plaster extension, because he could not exert a sufficiently strong pull. In these cases nothing remains to him but nail extension, that is to say, a method which exercises a continuous pull, as far as possible directly on to the peripheral fragment, exclusively by means of nails which are driven into or through the bones. (Fig. 1.)

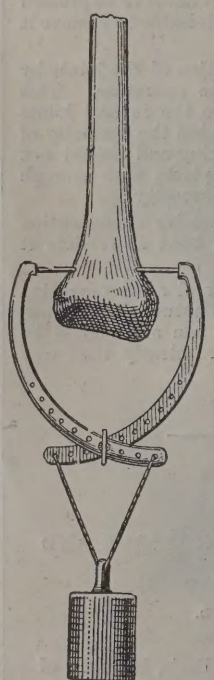
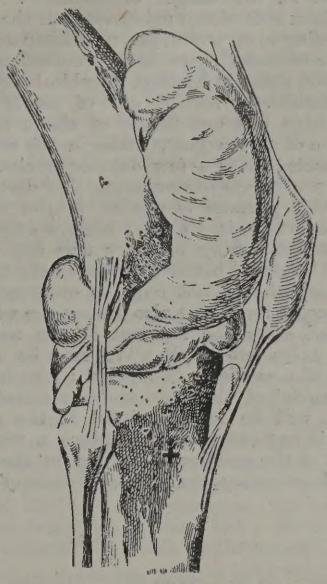


Fig. 1.—Nail-extension apparatus.

The technique which I have found in the course of years to be the best is extraordinarily simple. It is as follows: A nail with a pointed, four-sided end, is bored through the lower end of the peripheral fragment and the extension is fastened to the projecting ends of the nail. The length of the nail chosen is determined by the thickness of the limb at the place of insertion, and the nail, together with a pincette or forceps, is sterilized by boiling, it is then seized by the forceps and its posterior end which, like the other, is four-sided, is fixed into a hand drill. The nail is now pushed in down to the bone at a spot which has been previously decided upon and disinfected, as for example, by painting with iodine; next it is bored through the bone until the point perforates the skin on the other side and

the ends of the needle project equally on both sides. The process of boring can be carried out either by means of the drill attached to the nail or of Doyen's trephine or by electricity. Driving the nail through the bone with a hammer is to be avoided because of the shaking of the site of fracture, as also any preliminary incision or even a preliminary boring of the track for the nail through the bone. If the soft parts are thick



g. 2.—Positions for insertion of nails (femur and tibia).

it is a good thing to draw the skin in the proximal direction in order to avoid cutting the skin with the nail loaded with the extension apparatus.

Anæsthesia for the driving through of the nail may be carried out by a short narcosis, but very easily also by local anæsthesia. After the driving through of the nail the sites of exit and entry are covered with antiseptic gauze and a thoroughly sterile bandage; the projecting ends of the nail are thus kept free from germs to a considerable distance, so that should the nail become loose and slide to and fro only sterile parts will enter the nail track. The bandage must in any case protect the nail region from the prying fingers of the patient.

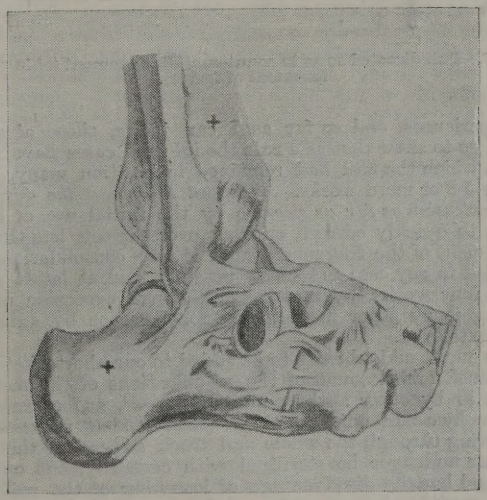


Fig. 3.—Positions for insertion of nails (lower end of tibia, os calcis).

In choosing the place for insertion of the nail we must take into consideration: First, that the nail must be altogether outside the fracture hæmatoma so that no infection takes place along the nail. To insure this in the case of fractures of the lower half of the femur we infringe upon the principle of direct attack upon the lower fragment, and insert the nail into the head of the tibia, and similarly in fractures of the lower half of the leg we drive the nail through the calcaneus. Secondly, we must avoid the medullary canal in order that, if the nail should become infected, osteomylitis may not result. Further, we avoid the joint capsule, because of the danger of joint infection. Finally, we spare the line of the epiphysis, although I have seen cases in which this was injured years before with absolutely no visible harmful effects.

From these considerations we have found the following to be the most suitable positions for insertion of nails:

One at the lower end of the femur immediately above the condyles, a second at the tibia about 2½ fingers' breadth below

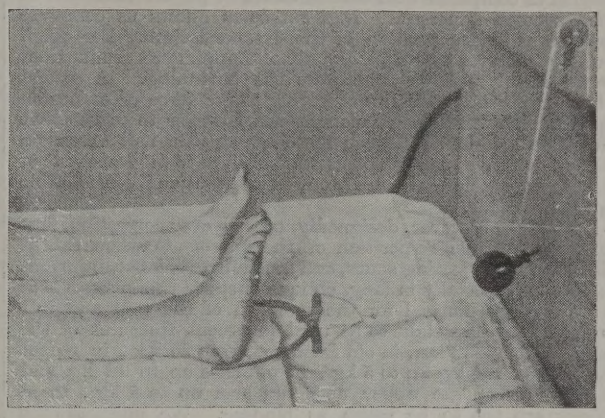


Fig. 4,—Nail-extension (os calcis).

the line of the knee joint (Fig. 2), so that the outer half of the nail comes to lie in front of the lower end of the styloid process of the fibula; another at the lower end of the tibia about two fingers, breadth above the line of the ankle (Fig. 3), so that the outer half of the needle passes in front of the upper end of the external malleolus; another at the os calcis 1½—2 fingers' breadth obliquely backwards and downwards from the tip of the external

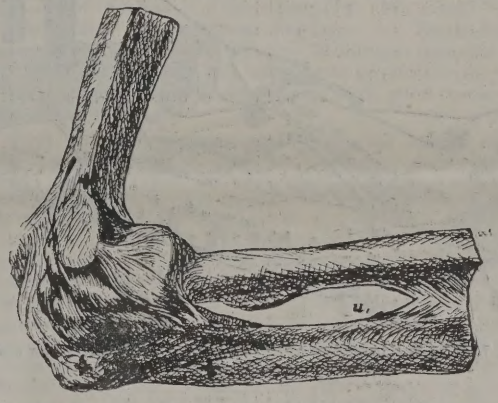


Fig. 5.—Sites of selection (three) for upper arm.

malleolus, that is, at the junction of the upper and middle thirds of the line of union of the corpus and tuber calcanei.

For the upper arm the site of selection lies at the lower end of the humerus immediately above the condyles, or better, in the olecranon, or even perhaps somewhat further towards the periphery in the upper end of the ulna (Fig. 5). For the extension of fractures of the elbow and forearm, the site is on

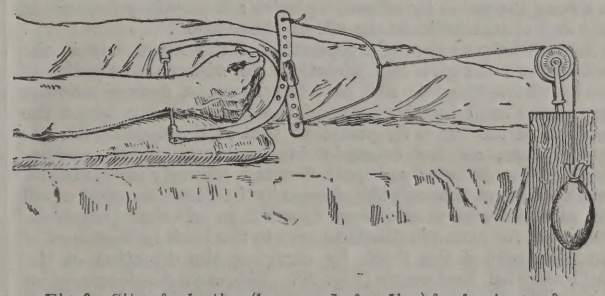


Fig. 6.—Site of selection (lower end of radius) for fractures of elbow and forearm.

the lower end of the radius, which is bored through about two fingers' breadth above the wrist joint from the dorsal side (Fig. 6). The thickness of the nail used should be from 3-5 mm.; its length varies with the thickness of the limb and must exceed it by a few centimetres. The upper ends of the two branches of my extension apparatus* are fastened over the

*Manufactured by Sanitatsgeshaft Schaerer A. J., Berne.

projecting ends of the nail, and the branches are fixed against one another in the right position by means of the wing screw which fastens together the two holes falling on one another. The extension grasps the lower ends of the branches on both sides (Fig. 7).

In carrying out nail extension, the great advantages of the method as compared with that of adhesive plaster extension at once become apparent. Nail extension allows us complete freedom as to the position of the extended limb. For thigh and leg fractures we may make use of Zuppinger's semiflexion, as we ourselves have done from the beginning. A second advantage is the possibility of giving to the force of extension any strength we wish. We ought not however to forget that the same weight acts much more strongly in nail extension than in adhesive plaster extension. Failure to take account of this stronger action led, earlier on, to unintentional considerable over-corrections.

I make use however, designedly, of such over-correction, first to make possible re-position of the fragments when this is hindered by projecting spurs, and secondly to combat injurious shortening especially in long, oblique or spiral fractures. There is no absolute normal for the strength of the pull and if I suggest that the weight to be used in recent fractures of the thigh is from 3-12 kg., in old fractures up to 25 kg., in recent fractures of the leg up to 5 kg., in old ones up to 12 kg. and in fractures of the upper and fore arm up to 4 kg., these figures are not to be taken as binding. We must always control the effect of the extension by the measuring tape and possibly by Röntgen rays and modify the extension according to the result. I do not need to enter upon the question of

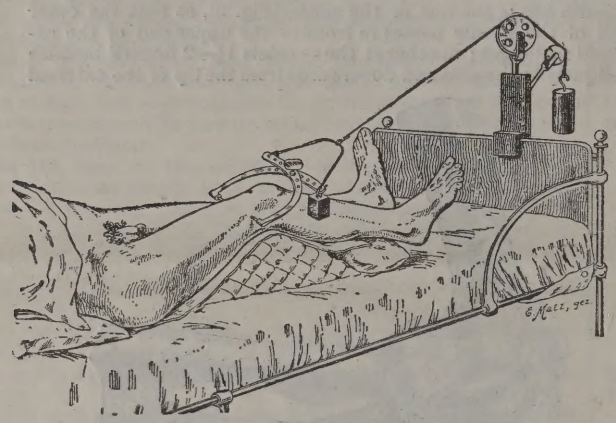


Fig. 7.—The two branches of the apparatus, and wing screw and attachment of weight.

counter extension, since this presents absolutely no difficulty, and in all my cases I have found it sufficient to raise the lower end of the bed.

Nail extension has been the cause of the greatest surprise to surgeons through its comparative painlessness. I have been able to treat a whole series of patients by this method without their knowledge, and although a certain number of patients may complain of pain for a short time, this pain is certainly not greater and, according to my experience, is decidedly less than in strong extension by adhesive plaster; it certainly does not in any way contra-indicate the use of the method.

A great help to the right reposition of the fragments is the fact that we can give any direction we wish to the pull. If the upper fragment is not, as often happens, drawn into the axis of the limb by the force of the pull, we can adopt the position of the lower fragment to that of the upper with the utmost ease, as for example in fractures of the upper third of the femur by a pull directed strongly upwards and outwards; but through the change in the direction of the pull we also influence sideways dislocation of the peripheral fragment, for example displacement to the back in fractures of the lower part of the thigh by carrying the direction of the pull somewhat backwards (Fig. 8). Sideways displacement of the peripheral fragment is corrected by transferring the pull more on to one end of the nail than the other, that is, more on one side of the apparatus, displacement ad peripheriam by hanging a weight on the one end of the nail, *i.e.*, on one side of the apparatus (Fig. 7). An advantage of this method of reposition as compared with that of Bardenheuer's side extensions, which is also at our disposal, is that in this the freedom of the limb is not affected, and the fracture region is left open to observation. A further great advantage of the method is that it requires only two points for its application, and for the rest leaves the whole limb free for early functional treatment. We can begin forthwith with massage and electrical treatment of the muscles, together with passive and active joint movements. Nail extension better meets the requirements of early functional treatment than does any other extension method.

One disadvantage, however, stands over against these great advantages, that is, the danger of infection. This is undoubtedly the black side of nail extension. If the treatment is carried out according to my technique, no mishap ought to occur. Yet in a number of cases there have occurred in connection with the nail spots, delay in healing, decubital ulcers, abcesses, and obstinate fistulæ. I myself, out of nearly 40 cases of nail extension, have had one fistula of about three months' duration, and one of over a year, while in the remainder, the nail sites were healed after a few days or weeks. We must, then, direct all our efforts to combating this dark side of the method. For this purpose is needed in the first place an absolutely complete asepsis. I have always emphasized that doctors who are not willing to carry this out in the most rigorous fashion would do better to abandon the method. But this careful asepsis should not only be observed during the passage of the needle itself, but also during the whole duration of extension, and after the removal of the nail should be directed to the holes left by it. We may be still doubtful whether the use of a needle in two parts (though we have as yet no usable model of this), or whether certain protective coverings, etc., will be found helpful in the fight against infection. But in any case one point plays a very important *rôle* in infection of the nail canal, and up to the present has received too little attention, that is the *duration of the extension.*

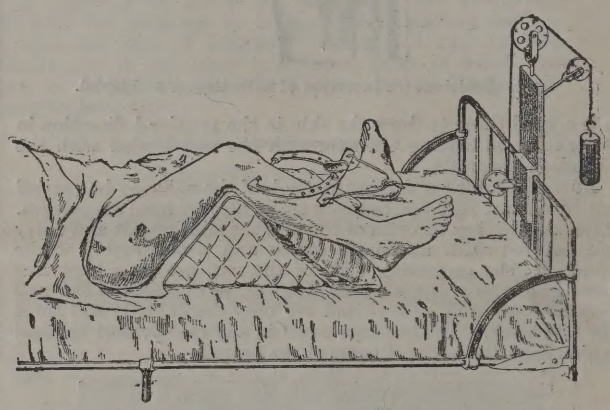


Fig. 8.—Pull directed so as to counteract displacement (of lower fragment of femur).

Our experiences, and so far as I can judge, those of other authors go to show that as a rule the infected cases have been those in which the nail had remained in position many, that is to say 5-8 or more weeks. *We must thus limit the duration of nail extension as far as possible* by the initial use of large weights to quickly correct, or even over correct, lengthways displacement of the fragments, and, if any consolidation has set in, but in any case as soon as possible, and at latest after three to four weeks, by removal of the nail extension or by replacing it by other methods, as for instance by adhesive plaster extension.

There ought undoubtedly to be added to our short sketch of nail extension an account of the modifications of the method brought in by other authors and by myself, as for example, extension by a nail on both sides which renders unnecessary the drawing through the whole nail track an end of the nail which can no longer be sterilized with certainty, but on the other hand has the disadvantage of loosening of the nail. A further modification consists in the so-called "splint nail extension," which is used for fractures of the leg especially in France, and which develops the extending force between one nail perforating the metaphysis of the upper fragment and one perforating that of the lower fragment. Although the method may fix the fractured segments of the limb more firmly, it is on the other hand more complicated, it diminishes access to the fractured spot, and what is of greatest importance it doubles the danger of infection. My recently published monograph "Die Nagel extension der Knochenbruche*" is at the disposal of those who wish to inform themselves as to all the forms of use of nail extension and their exact technique.

*Dr. Steinmann. Die Nagelextension der Knochenbruche. Neue Deutsche Chirurgie I., Bd., 1912 bei Enke, Verlag, Stuttgart.

And now with regard to the indications for the use of nail extension. I do not attempt to maintain that my method should replace that of adhesive plaster extension. Where we succeed with the latter and are in a position by means of it actually to bring about reposition then plaster extension is the method of choice. But experience has shown there to be a whole series of different fractures in which the doctor fails to accomplish his object by the above method; these cases are naturally less numerous for those technically perfected in the method of adhesive plaster extension than for the majority of surgeons. We must, however, reckon with the latter. Among recent fractures, complicated ones are especially the ones which often do not admit of adhesive plaster extension, and which, therefore, up to now have often given miserable results. These are some of the most satisfactory cases treated by nail extension which, along with adequate extension, permits of unhindered access to the complicating wound and therefore of a rational treatment. But there are a large number of uncomplicated fractures in which, up to now, inadequate and bad results have been obtained with plaster extension and in which nail extension is able to do good service.

I agree with Körber, who till now has worked up the greatest material in nail extension cases and has done so very critically that nail extension is indicated for the lower limb in :—(1) Fractures of the upper third of the femur with a short upper fragment displaced to the front and outwards; (2) Dislocated transverse fractures of the middle third of the femur in which reposition is a matter of difficulty; (3) Fractures of the lower third of the femur with obstinate dislocation of the lower fragment backwards; (4) Knee joint fractures, especially if the diaphysis is driven into the epiphysis; (5) Fractures of the lower half of the leg with dislocation, not easily reducible, of the proximal fragment to the front; (6) Supra malleolar or malleolar fractures with much displacement.

Of upper arm fractures, according to Wilm, fractures of the lower end of the humerus are to be submitted to nail extension, and this also can well be applied to obstinate fractures of the forearm.

Nail extension has also been held to be specially indicated for comminuted, double, and multiple, fractures.

In addition to a complicating wound, other factors such as smallness of the available surface for attaching adhesive plaster, injuries of the skin, obesity, &c., may make plaster extension impossible, and forces us to have recourse to nail extension.

Perhaps the type of fracture which best rewards nail extension is that of old fractures, specially those in which as a result of accidental wound diseases or intercurrent illness or unfavourable complications such as eczema, decubitus, gangrene, &c., the methods first tried, as for instance adhesive plaster extension, either failed or could not be carried to a termination. Here nail extension, with its strength of action can still, after some weeks, remedy what has been neglected. Similarly nail extension may be expected to play a great *rôle* in war. When shot fractures reach the terminal hospital after many days or weeks, only nail extension will usually be adequate to make good the displacements and shortenings which have occurred. In recognition of this the Prussian army has incorporated my instrumentarium in its medical outfit for war. Nail extension has quite especially conquered for surgery the territory of old fractures which have healed with great deformity and shortening, inasmuch as in these, after a second artificial fracture, it has made good shortenings of many cm., even up to 11, 12 or 13 cm. With the method—as Kirschner says—we can undertake tasks hitherto impossible.

Nail extension is also used for the correction of other forms of shortenings of the limbs, as after scalariform sawing of the bones, further in the re-position of old luxations, in the treatment of coxa vara (Sprengel), in the mobilization of stiffened joints (Payr), and even for the correction of club foot. The method is so new that obviously the region for its employment is still not sharply defined. My purpose has been specially that of shewing you that in cases of fracture in which other methods fail, you no longer, as formerly, stand helpless, but have a method to fall back upon which can do good service under the most difficult conditions, and can even make good the unsatisfactory results of other methods.

APPENDIX (H.)

(1) THE TREATMENT OF FRACTURES WITH EXTENSION BANDAGES; AND THE RESULTS OBTAINED THEREBY.

By GEHEIMRAT PROF. DR. BARDENHEUER, and STABSARZT DR. GRÄFSNER, of Cologne.

(From Publication in honour of the Opening of the School for Practical Medicine in Cologne, compiled by Prof. Bardenheuer, 1904, pp. 113-128.)

Perhaps there is no joint fracture in which an error on the part of the doctor treating it is so severely avenged as ankle-joint fracture, whether the error is one of diagnosis in looking upon fractures as distortions and treating them as such or of failure in treatment after a right diagnosis of fracture. Either the doctor immobilizes the injured joint too long and causes subsequent stiffness or he allows the foot to be used too early, so that deformities occur and cannot afterwards be removed. In either case function is and as a rule remains considerably impaired. Every doctor who has many cases of accident to report on knows how great these injuries often are. But even in those cases of ankle fractures which had been treated in large hospitals and in the treatment of which the right proportion of immobilization, movements and rest in bed, had been maintained, we found misplacements and inflammations which considerably affected the power of making a living. The treatment had always consisted in fixation of the foot in a containing bandage (usually a plaster bandage), so that we must acknowledge to ourselves that these bandages are not always in a position to remedy displacements and to prevent the harmful results of a joint fracture. We would, however, maintain that the extension bandages, as Bardenheuer has made use of them in the Cologne Municipal Hospital for the last twenty years, have not failed us in any fractures, not even in ankle fractures, and that, rightly used, good results will be obtained throughout.

When Bardenheuer's assistants reported on the results of extension treatment in ankle fractures—Loew (*Deutsche Zeitschrift für Chirurgie*, Bd. 44: on the results of fractures of the leg in respect of the accident insurance law) and Bliesener (the same journal, Bd. 55: on the functional results obtained through Bardenheuer's extension method in fractures of the lower limbs), their results were described by the one as fabulous, by the other as ideal. That these have been equally good also in the following years (1897—1903) should be made manifest in the following article. But first the method of carrying out Bardenheuer's extension must be shortly described. Bardenheur has expressed himself more fully on the subject of extension in his text books, in the 1903 volume of the discussions in the German Society for Orthopædic Surgery, and finally in a larger work in the *Archives Internationales de Chirurgie*.

For a satisfactory carrying out of extension, beds are needed with a hard substratum, preferably a mattress, since the extended leg is not laid, as in the usual treatment, in a splint, but lies directly on the bed. It is desirable for the beds to be long: for hospitals we recommend beds of 2·4 m. in length and 0·85 m. in breadth. Further, a thoroughly adhesive non-irritant plaster is necessary, Formerly, in using the customary grey canvas adhesive plaster the onset of eczema often made it necessary to remove the bandage, and rendered the result of treatment a matter of doubt. Since we have used collemplastrum zinci on grey canvas (Helfenberg Chemical Works) and leukoplast (Beiersdorf), we have not again seen eczema occur even in this hot summer. We fasten the adhesive plaster strips, which are laid on the unshaved skin, by circular overlapping turns of perforated mild indiarubber plaster, 3 cm. in width. The adhesive power of this plaster is so strong that a length extension on the leg can be forthwith weighted with 25 kg. without disturbing the plaster.

As is known, Bardenheuer not only seeks to make good the dislocatio ad longtitudinem by a pull lengthways, but also the dislocatio ad axim, ad latus, ad peripheriam through transverse and rotation pulls.

To apply lengthways extension to the lower limb, the malleoli and the anterior border of the tibia are first protected by strips of gauze, evenly laid on, and the strip of adhesive plaster then carried downwards on the outer side of the leg from behind the trochanter. The plaster forms a stirrup under the sole and goes up again on the inner side of the leg. These strips are made firm, as was stated above, by circular turns of

perforated adhesive plaster. The knee joint, however (as indeed all joints), and the thigh for four fingers' breadth above the knee joint are left free; the former in order not to injure the joint movements, the latter, in order that in any possible yielding of the circular turns of plaster, the knee joint shall not be compressed and its circulation interfered with. In fractures of the malleoli, and of the lower third of the leg, however, we carry the circular turns to the ankle in order to be able to exert an effect on the lower fragment. This effect will be strengthened if we sew up the loop of adhesive plaster close in front of the sole, or insert into it a buckle (like the buckle of braces). In loading the extension, a strong pull will be exercised on the malleoli and "spring" joint; the foot can be carried either outwards or inwards. It is often considered doubtful whether the skin surface, and therefore the surface for attack by adhesive plaster strips in supra-malleolar or malleolar fractures is not so small that the lower fragment cannot be influenced. The two Röntgenograms I. and II. should contradict this view.* This pull upon the lower fragment is however of great advantage especially in the treatment of malleolar fractures, since through it, the hinder part of the foot can be brought into the right position, This position is not always obtained by putting the foot into plaster of Paris; the foot certainly is supinated at Chopart's joint but without the deformity at the malleoli being corrected by the displacements in the talocrural joint. With the extension bandage by which the position of the whole foot including its posterior part is kept under lasting control this defect can always be avoided. As we have already said, the extension bandage is applied far above the seat of the fracture. This is often a cause of surprise. But, as Bardenheuer's experiments on the recent body have shown, it is a mistake to think that the action of the pull is thereby affected. The adhesive plaster strip reaching up above the seat of fracture is not so much made fast to the bone as to the movable soft parts. The characteristic force of extension, however, acts chiefly on the parts of bone lying peripherally from the fracture and finds in these its special areas of attack, acting through the long strips which are pressed in by the circular turns of bandage. In this way only is it possible for us in a number of fractures to apply the necessary weight. Counter extension is effected by raising the foot end of the bed.

In all malleolar fractures we bring the length extension of the foot upwards (towards the toes, the ceiling) with a weight on an average of 1 kg. By this pull pressure is taken off from the heel and in addition it keeps the lower fragment more safely in position and prevents turning in of the toes. In ankle fractures which are to be put into a position of marked supination it serves as a substitute for the rotation strips which we formerly used. An adhesive plaster strip is applied to the dorsum and sole of the foot so as to form a loop over the tips of the toes. To give this extension the necessary hold, the circular turns must be firmly applied because in this way a hold is obtained at the heads of the first and fifth metatarsal bones. The same pull may also be effected if, after padding the heel with folded strips of gauze, the adhesive strip is brought round the heel along both edges of the foot and sewn up over the tips of the toes; the latter arrangement is useful in luxation of the foot to the back, because in such a case a heavier weight is needed on the extension. For transverse extension we need a pull perpendicularly to the long axis of the bone. The transverse pulls are applied to the peripheral and central fragments and by drawing them in a frontal and in a sagittal direction to the long axis of the bone, remove the dislocation.

The method of application of a transverse extension is to carry an adhesive plaster strip round the circumference of the limb and to sew it in the middle of the side, so as to form a loop by means of which the pull will act. A hole is cut in the loop and the cord for hanging the weight is fastened to a piece of wood set in the loop.

Leverage of the fragments in more marked dislocation to the side is strengthened by the application of further transverse pulls through which the fractured ends are drawn to the opposite side from that to which they were dislocated and the neighbouring joints are drawn to the same side. The fragments are thus levered back to the long axis of the bone.

A further improvement introduced by Bardenheuer is the adoption of rotation pulls to make good any rotation of the broken parts of bone and also the methods introduced by him for the raising of depressions and the avoidance of differences of level.

The rotation pull is made by a single circular turn of an adhesive plaster strip to whose free end a loop is sewn.

For making good differences in level Bardenheuer uses the so-called "cradle," (Figs. 1, 2, 3.) The action is evident from the illustrations. The simplest form is that shewn in figure 3. Two transversely laid, somewhat bent sheet iron bars are joined together by lengthways bars, over which run rollers. The plaster strip is laid over the fragment which needs to be depressed, brought through under the wheels and suitably weighted at both ends.

In all these pulls to the side we let the cords to the sides of the bed simply hang over the bed side, not run over rollers. For the lengthways pull we introduce a roller at the foot end of the bed (Fig. 4), though a hole bored in the foot board would answer the same purpose. For carrying the pull upwards we use the pole shown in Figure 5.

We do not use any other apparatus, so that the reproach that the extension needs a great deal of complicated apparatus is not justified.

By means of the pulls we have described we can keep the fragments in lasting contact after reposition, even in cases of the most severe displacement, and we can bring about healing of the fragments in the anatomical sense as the appended Röntgen pictures prove. Even if it must be allowed that a fracture which has healed with some slight displacement of the fragments does not necessarily cause any considerable disturbance of function, yet a perfect apposition of the fragments offers great advantages. First in importance is the fact that the time of recovery is shortened. Bardenheuer does not agree with the opinion of Voelker that the long duration of treatment, as we have it, in the joining of the fragments by a stitch through the bone, is to be considered to be due to the scanty formation of callus resulting from the exact adaptation of the fragments. According to him the excessive callus is much more the expression of defective contact between the surfaces of the bone, just as an excessive scar formation in the soft parts is the expression of a defective apposition of the edges of the wound as in secondary wound infection with yielding of the edges. Bardenheuer hence speaks of bone healing by first intention, and desires in the healing of a fractured bone, just as of skin wound, a primary union with as little scar, that is callus, as possible. The importance of a small formation of callus in or close to a joint as far as function is concerned, is clear. Further, it is obvious that through accurate adaptation of the fragments in a joint fracture the irritation caused by fragments of bone on the synovial membrane, the periosteum, the joint capsule and the surrounding muscles, is avoided.

Finally the extension pulls, besides leading to the correct retention of fragments, allow of passive and active movements of the joints concerned, even during the special fracture treatment.

In this way stiffening of the joint is avoided, and also the other injuries which long resting of an injured joint, filled with an effusion of blood, brings in its train. Through early passive, but, above all, active movements, we maintain the elasticity of the muscles of the synovial membrane, and of the capsule; nutrition is aided, the development of œdema is avoided as a result of the furtherance of the blood and lymph stream, adhesions of the tendons with the tendon sheaths and with the surrounding tissue, inflammatory adhesions of the joint surfaces, the surrounding capsule and the muscles with one another, and inflammatory shortening, and atrophy of the muscles are all avoided. Bardenheuer's extension treatment gives a joint which, after the end of the fracture treatment, is so freely movable that a medico-mechanical after-treatment is for the most part unnecessary.

In applying the bandage after reposition of the fragments, a helper grasps with one hand under the heel, with the other round the dorsum of the foot, and powerfully extends the lower fragment. After removal of displacements, the foot should be in a position at right angles to the axis of the leg, midway between pronation and supination, and should be so rotated round the axis of the leg that the inner edge of the great toe lies in a line with the inner edge of the patella, placed horizontally. As a rule, in malleolar fractures we put on an extension bandage, with the foot in a position of adduction. (Fig. 6.)

The pull *d* is first applied to draw the foot forwards (towards the ceiling) then the length extension *a* and the transverse pulls *b* and *c*. Through the pull *a* the foot is brought into adduction, through the transverse pull *b*, the lower end of the leg is drawn outwards, through *c*, the upper end is drawn inwards so that the lower end of the leg is levered outwards. The loading of the pulls is shewn in the illustrations.

The accompanying Röntgen pictures should prove the effectiveness of the bandage (Röntgenogram 1, *a* and *b* were taken before, *c* and *d* after the treatment of the fracture).

* It has not been possible to reproduce here the Röntgenograms and other figures referred to in this Appendix.

Warnings have often been given before as to keeping the foot during recovery permanently in the varus position. We allow this plea to hold good for many cases of adduction and inversion fractures, since in such cases placing the foot in the position of supination would throw the fragments at the outer malleolus still further from one another. In these fractures a groove remains palpable at the outer malleolus even after recovery; œdema and a condition of irritation in the ankle joint remains present for some considerable time. Our custom, therefore, is to apply the bandage for adduction fractures in the way shewn in figure 7; the length extension pull *a* is brought towards the outer side of the bed for the adduction of the foot; the transverse pull *b* inwards for the lower end of the leg, the transverse pull *c* outwards for the upper end of the leg. The foot remains in this position for *6* to *7* days; then we bring it into a position of slight supination (Röntgenogram II.)

In fracture of the anterior border of the tibia, a not very rare accident, we bring the foot into as great dorsal flexion as possible by the pull to the front (towards the ceiling). We have always obtained a good functional result and never seen any limitation of dorsal flexion.

One point needs attention in the treatment of ankle fracture, namely, that of making good the diastasis between the tibia and fibula, which arises in many malleolar fractures. Often there is only a tearing of the lig. tibio-fibularia. In most cases, however, the ligaments are more resistant and more or less large fragments are torn out of the outer surface of the tibia. These fractures usually go along with a fracture of the fibula a little above the external malleolus. If such a diastasis is not removed the astragalus does not find the necessary hold in the fork of the ankle; flat foot develops and uncertainty of gait, etc. (Röntgenogram VII.) Clinically in this fracture we find a narrowly localized pain on pressure at the outer surface of the tibia. In such cases the plaster of Paris bandage cannot exercise the necessary pressure on the malleoli without inducing pressure gangrene. But the extension bandage brings about the removal of the diastasis through the length extension, if the limbs of the ansa are brought close together by means of a buckle just in front of the sole, and so a continuous pressure is brought to bear upon the malleoli (Röntgenogram III).

Lateral displacements of the foot, of small grade, are fully made good by means of the adduction and abduction extension bandages. On the other hand, in more severe displacements, in true luxation, the so-called dislocation fractures, the adduction and abduction position of the foot in the bandage is further strengthened by transverse pulls.

In luxation of the foot in the talo-crural joint outwards, the foot, which is laid in an adduction extension, is brought into more marked adduction by the transverse pull *d*, which is laid over the ankle. (Fig. 8, Röntgenogram VI.) Reduction is easily accomplished with the knee flexed by carrying out adduction and rotation of the foot to the inner side. Figure 9 explains the treatment of luxation of the foot in the talo-crural joint inwards.

Abduction extension. Strengthening of the abduction through the transverse pull *d*.

Reduction must be carried out through abduction and rotation of the foot outwards, the knee being bent. Figure 10 illustrates luxation to the front. Through the pull *d* the foot is flexed dorsally, through the longtitudinal pull *c* it is drawn downwards (plantarwards) through the pull *d* to the back. Through the pull *a* the lower end of the tibia is pulled to the front, through *e* the upper end is pulled to the back, so that the lower end of the tibia is still more powerfully acted upon. (Pull *d* and *e* are transverse pulls which are sewn up at both sides of the bone and end in loops. Through weighting on both sides a powerful pull is exerted towards the back (substitute for the cradle pull). Reposition in incomplete luxation is arrived at by simple extension of the foot towards the back; in complete luxation it is a good thing to press the foot, strongly flexed dorsalwards, to the back and down and the lower end of the tibia to the front and produce a plantar flexion. (Röntgenogram IV.)

Luxation to the back is treated as in Figure 11. Through pull *c* the foot is pulled downwards plantarwards, through *b* in its long axis toewards, throught the cradle pull *d* the lower end of the tibia is pulled to the back; through *a* the upper end is pulled to the front, so that the lower end is levered towards the back.

In incomplete luxation the pull at the foot to the front, while the leg is pressed towards the back, is sufficient to bring about reposition. In complete luxation the foot must first be plantar flexed, then pressure be applied on the tibia towards the back and a pull on the plantar flexed foot towards the front and finally the foot be dorsally flexed (Röntgenogram V.)

If there be an accompanying displacement of the foot to the outer or inner side, this can be made good by carrying the length extension to the inner or outer side and by heavier weighting of the pull on the outer or inner side.

We use the extension bandage in complicated fractures if the wounds of the soft parts are small and we almost always use it in compound fractures. The neighbourhood of the wound is cleaned and covered with a smoothly laid strip of vioform gauze and with a mull compress. Over this the adhesive plaster strip is laid. When there is little secretion the vioform gauze remains until the wound heals and the extension bandage is taken off; otherwise it is changed as it may be necessary without the length extension needing to be taken off.

From the fifth day after the application of the bandage, onwards, the weights are dispensed with for an hour at the morning and evening visits and movements at the foot joint undertaken, first passive then active. Flexion, extension, and rotation are, however, only carried out so far as no pain is felt on the movements. After 3-4 days there is, as a rule, decidedly active mobility.

All fractures are Röntgen-rayed before the application of the bandage; in severe displacements we apply the rays again immediately after the application of the bandage, otherwise first after eight days in order to be able to make good through different weighting of the pulls any small displacements which, though not perceptible clinically, may be shown by the rays.

The extension treatment lasts on an average—

For fractures of the malleolus externus ...	12 days,
,, ,, ,, internus ...	14 ,,
,, ,, ,, both malleoli	14 ,,
With accompanying marked luxation	16-18 days.

Our principle is to let all cases with ankle fractures even if no displacement is present, lie in bed for 5 weeks. The body weight should only be borne on an absolutely firm bone. In extension treatment especially, the patients do not need to stand up as they do when fixative bandages are used, since the muscles in extension are not condemned to complete inactivity. Ambulant bandages we do not apply. The results of the extension treatment in malleolar fractures, as they are supplied in the following statistics, we have determined by questions addressed to sick clubs and trades unions. We have received information in the kindest manner from 35 sick clubs (one refused information) and from the following trade unions, to whom we now express our thanks:—

1. Rheinisch-Westfälische Baugewerks—B.-G.
2. Hessen-Nassauische Baugewerks—B.-G.
3. Fuhrwerks B.-G.
4. Norddeutsche Holz—B.-G.
5. Lagerei B.-G.
6. Maschinenbau and Kleineisen-Industrie—B.-G.
7. Strassen—and Kleinbahn—B.-G.; and
8. der Königlichen Eisenbahn Direction, Cöln.

The questions we put were:—

1. If complete fitness for work was regained.
2. In case of complete fitness for work not having been yet regained:—
   (a) Is the incapacity permanent?
   (b) What is the percentage amount of incapacity?
   (c) What is the cause of the incapacity?

In putting our questions we have followed the example of Loew and Bliesener in order to be able to compare our results. We have differed from them only in so far that we have counted amongst those in receipt of sick pay not only those in receipt of permanent sick pay, as Loew and Bliesener have done, but also those who at the time of preparation of the statistics were drawing sick pay. In what other way should we count persons who at that particular time were drawing sick pay, and about whom it was not yet established whether they would do so permanently? Our statistics embrace the time from 1897 to 1st April, 1903. We have collected our information in April, 1904. All those who at this time were receiving pay are included. It is clear that in consequence our results must compare unfavourably with those of Loew and Bliesener.

Besides ascertaining those in receipt of sick pay, we also were concerned in determining who, among the injured persons, were fully fit for work before the thirteenth week, who after this time. We have not estimated the exact duration of recovery, since this is so largely determined by external circumstances, particularly if it is a question of fitness for work before the beginning of the 14th week, since with regard to this time the kindness of the doctor and the goodwill of the patient will play a great part. But even after the end of the 13th week the reckoning is not uniform, since the procedure in different trade unions with repect to full and partial pay is different.

In order to satisfy ourselves, personally, as to the results, we have sent for the people concerned, and the greater part have appeared for an after-examination; unfortunately, only 2 of the 7 in receipt of pay were amongst these.

We have for our statistics, reports on 149 cases of injury (1897–1903):

Fracture of a malleolus	86
Recovered before the completion of 91 days	75=87·2 %
Recovered after 91 days	11=12·8 %
In receipt of sick pay	0=0 %
Fracture of more than a malleolus ...	68
Recovered before the completion of 91 days	42=66·7 %
After 91 days	14=22·2 %
In receipt of sick pay	7=11·1 %

Thus for ankle fractures generally the following are the figures:—

Ankle fractures	149
Recovered before the completion of 91 days	115=77·2 %
After 91 days	27=18·1 %
In receipt of sick pay	7=47 %

Statistics of Loew (1891–1896):—

Fracture of a malleolus	68
Recovered before the completion of 91 days	58=85·3 %
After 91 days	10=14·7 %
In receipt of sick pay	0=0 %
Fracture of more than a malleolus ...	38
Recovered before the completion of 91 days	21=55·4 %
After 91 days	16=42 %
In receipt of sick pay	1=2·6 %
Ankle fractures in general	106
Recovered before the completion of 91 days	79=74·6 %
After 91 days	26=24·5 %
In receipt of sick pay	1=0·9 %

Statistics of Bliesener (1896–1897)—

Fracture of a malleolus	9
Recovered before the completion of 91 days	8=89 %
After 91 days	0=0 %
In receipt of sick pay	1=11 %
Fracture of more than a malleolus ...	21
Recovered before the completion of 91 days	18=85·7 %
After 91 days	3=14·3 %
In receipt of sick pay	0=0 %
Ankle fractures in general	30
Recovered before the completion of 91 days	26=87 %
After 91 days	3=10 %
In receipt of sick pay	1=3 %

Putting together our results and those of Loew and Bliesener, we obtain the following:—

Ankle fractures	285
Recovered before the completion of 91 days	220=77·2 %
After 91 days	56=19·6 %
In receipt of sick pay	9=3·2 %

For further comparison the statistics of Haenel and Jottkowitz may be taken.

Haenel, who first provided statistics of accidents reports in *Deutsche Zeitschrift für Chirurgie*, Bd. 38 ("On Fractures with respect to the Accident Insurance Law") on 40 malleolar fractures: of these 28=70 % were recovered, 12=30 % were disabled.

In any comparison with this result it is, however, to be considered that these cases were not treated on any uniform method, and to a large extent not in hospital. More informative is a comparison of our statistics with those of Jottkowitz (*Deutsche Zeitschrift für Chirurgie*, Bd. 42, "On Results of Fractures of the Leg in connection with the Accident Insurance Law"). Jottkowitz reports on 50 ankle fractures from the Knappschaftslazerett at Königshütte, the cases being all treated on a uniform method in the same hospital:—

Fracture of a malleolus	36
Recovered before the completion of 91 days	29=80·6 %
After 91 days	1=2·8 %
Disabled	6=16·6 %
Fracture of more than a malleolus ...	4
Recovered before the completion of 91 days	0=0 %
After 9 days	1=25 %
Disabled	3=75 %
Ankle fractures in general	40
Recovered before the completion of 91 days	29=72·5 %
After 91 days	2=5 %
Disabled	9=22·5 %

Jottkowitz does not mention whether the cases described by him as disabled were drawing permanent sick pay; the word seems, however, generally not to indicate permanent sick pay.

It may be mentioned that of the 149 cases with which our statistics deal, 20 had passed the 50th year of life (one was 61 years old). In half of these cases the injury was fracture of both bones. 19 have become fully fit for work, 1 is drawing permanent sick pay of 33⅓ %. The restoration of the function of the injured joint in these older people must specially be taken as proof of the good effect of the extension bandage.

The following short extracts from the notes of the 7 persons in receipt of sick pay may be appended:—

1. N. 32 J.—Jumped a metre's length, the right foot twisted.

Fracture of the malleolus externus and of the whole external tibial surface with displacement of this fragment forwards. After 35 days left the hospital with good position of the foot. 33⅓ % on account of arthritis in the ankle.

2. L. 59 J.—Falling of an iron ladder from the outer side on to the right foot. Fracture of both malleoli and of the external tibial surface with luxation of the foot outwards and backwards. Discharged after 47 days with good position of the foot but slight impairment of flexion. Slight abduction position; on the sound side position of flat foot. Should wear a support. 33⅓% on account of inflammatory traumatic flat foot.

3. F. 28. J.—Fell with his left foot in a grating. Fracture of the internal malleolus and fibulæ supra-malleolaris.

Discharged after 31 days with a good position of the foot, slight impairment of dorsal flexion. 15% because of weakness in the foot.

4. M. 40 J.—Run over by an automobile. Fracture of the external malleolus and of the external surface of the tibia. Discharged after 45 days with slight limitation of movement. 20% because of weakness of the foot, until further notice.

5. F. 25 J.—Twist of the right foot. Fracture of the internal malleolus and supra-malleolar fracture of the tibia. Discharged after 48 days with good position of the foot without impairment of movements. 15% because of slight symptoms of flat foot until further notice.

6. W. 38 J. Twist of the foot. Fracture of the malleolus externus and of the external surface of the tibia. Left the hospital against medical advice after four weeks, with good position of the foot and good function.

10 % until further notice because of weakness of the ankle.

7. D. 31 J. Twist of the foot. Fracture of both malleoli and of the external surface of the tibia. Flat foot both sides. After 36 days discharged with good function.

10 % until further notice because of symptoms of flat foot.

In cases 1 and 2, permanent sick pay is probable even though not yet awarded. In the 5 other cases the bestowal of sick pay is only temporary. If, like Loew and Bliesener we only bring into our reckoning as receivers of sick pay those with permanent sick pay, we have for the years 1897-1903 only 2 = 1·3 %, for the years 1891-1903 4 = 1·4 %.

The greater number of fractures of both malleoli, as compared with the reports of Loew and Jottkowitz, is explained by the fact that we, as Bliesener had already done, believed it necessary to count among the combined ankle fractures that common form of fracture, the fracture of Dreieck at the outer surface of the tibia (Volkmann's fracture).

No one will doubt that our results collected from impartial accounts are truly good. Yet there remains behind, according to Borchardt (Handbook of Practical Surgery, 2nd edition), in about 25 to 30 % of the cases of malleolar fracture treated on other lines a limitation of the capacity of use of the foot of differing degree (up to about 50 % capacity for work).

Why is it that the extension treatment, in spite of its good results, does not find the general use which it deserves?

The objection is raised that it is difficult to learn, and because of the difficulty of the technique and the necessity for constant supervision is only suitable for use in hospitals. Bardenheuer has expressed his view with regard to these objections at the conclusion of his work, mentioned above, in the *Archives Internationales*. According to him treatment in hospital is indicated for fractures with great dislocation of the fragments, and for fractures into or in the neighbourhood of the joint; such treatment is almost always given in the larger towns, if for no other reason because in these the Röntgen apparatus is always now provided, and a control as to the position of the fragments in joint fractures is indispensable. Gymnastic exercises during the special fracture treatment should only be carried out by the doctor himself or by trained persons under the supervision of the doctor. Bardenheuer admits that the extension treatment demands much care, diligence and a steady supervision. But the greater care and trouble is rewarded by the far shorter period of consolidation, still more by the shortening of and in many cases the dispensing with after treatment, but above all by the far better functional result. That these advantages far outweigh the

apparent disadvantages of hospital treatment, the greater outlay, the separation of the patient from his family, etc., does not need to be insisted on.

If, from the records of trades unions and disablement insurance, it were shown how many of those in receipt of sick pay were unfitted for work or had a diminished power of work as a result of a fracture, the great number of these cases would cause astonishment. It is evident that a large sum would be saved to the State and a great amount of strength for work saved, by diminution of the number. Considered from this social standpoint an effort must be made in the large number of fractures to obtain as good functional results as possible and this can be done in most cases only in hospital. It is therefore to the interest of the trade unions, but also of the community and the State, which have often to step in to the aid of injured persons unfit for work, if not insured against accident, to aim at the treatment of recent fractures in hospitals, and of trade union cases preferably in special hospitals. Bardenheuer believes the last demand to be so far a just one, that he has divided from the other parts of the hospital a special department for fractures and consigns it to the care of an older assistant, who for the most part is only concerned with the treatment of fractures.

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(2) ON THE TECHNIQUE OF THE EXTENSION TREATMENT.

Oberarzt Dr. Schrecker, of Cologne.

Kommandiert zum Bürger-hospital.

(*From the Deutsche medizinische Wochenschrift, No. 39, 1908.*)

Bardenheuer's extension treatment of fractures is of such great interest that it seems to me well to call attention to certain changes which we have recently made in the technique of the method.

When the extension treatment is carried out on Bardenheuer's system, the transverse pull or, in the case of a pull to the back, the so-called "cradle pull" is indispensable. Formerly, for the application of these pulls, instead of the rather costly apparatus described in Bardenheuer's and Graessner's text book, we employed a "cradle," which was composed of two long bars, provided with wheels, the bars being joined to one another by transverse somewhat curved sheet iron bands. The strip of adhesive plaster, folded double, and made as usual out of canvas, was laid over the site of the fracture which needed to be pressed back, then carried through under the wheels and suitably weighted at both ends.

These cradles had the disadvantage of not being sufficiently steady; they were easily displaced and the pull, in consequence, was frequently transposed to sites lower than had been intended. Moreover, as the result of the tendency of the pull to move towards the back, the chief point of action came to lie more on the lower segment of the cradle. The result was that the upper part tended to be raised to the front, and the effect of the pull was naturally weakened.

I have tried to avoid this disadvantage by laying the cradle on an evenly firm surface, and by adding an adjustable sliding apparatus. This arrangement had the additional advantage of dispensing with a considerable part of the friction, unavoidable when the limb lay directly upon the mattress. Such friction was cited by Sprengel, amongst others, as a material disadvantage of Bardenheuer's method.

The board with its adjustable slide* apparatus consists of a polished beechwood surface, on whose sides, as is seen in the illustration, grooves are made: in these the slides are fixed at will with screws at the place corresponding to the desired pull. The slides are so arranged that they can be pushed towards the middle of the board and the distance between them can be adequately adapted each time to the circumference of the limb; for the rest their structure is similar to that hitherto in use, that is to say, they consist of rods over which the rollers run.

Formerly, in making the extension bandage, we used exclusively zinc oxide adhesive plaster on grey canvas; this was made firmer by overlapping turns of perforated mild india rubber plaster; both kinds of plaster were prepared at the Helfenberg Chemical Works. Now we chiefly make use only of Heusner's resinous adhesive plaster, and limit the use of the other plaster to smaller bandages on the upper limb and to children. Heusner uses for his adhesive fluid a solution of Venetian turpentine in spirit in the proportion of 1 : 2. According to his prescription, only the best turpentine is used—a clear fluid, like honey, of a yellow-green colour and pleasant resinous odour; the cheaper kind allowed by the pharmacopoeia possesses less adhesive power.

The solution is sprayed on to the limb by means of a spray apparatus (like an iodoform ether spray); then a strip, 8-10 cm. in breadth, of rough woollen or cotton material (thick cloth, fustian, beaver) is applied in the ordinary way to both sides of the bone—the malleoli and anterior border of the tibia are to be protected from pressure by smothly folded strips of gauze—and fastened on by a few turns of bandage, with an accompanying light massage. In the stirrup at the sole of the foot is placed either a small piece of wood or—what, according to Heusner, is better—a roll in the form of a cotton reel, which indents less and can be easily moved.

Heusner finally surrounds his bandage with a starched gauze bandage, in order to give it greater stability. The latter is not, however, absolutely necessary, and the object can be attained by spraying some of the adhesive fluid on to the upper part of the thigh before the end of the bandaging, and applying the turns of bandage in this situation very carefully and somewhat firmly.

According to Heusner, the extension bandage is at once able to bear a weight of 20 kg. and more; it gives rise to no symptoms of irritation, and fulfils all the conditions of a thoroughly adhesive bandage.

It has various, not unimportant, advantages as compared with the customary adhesive plaster bandage:

(1) It is extraordinarily cheap. An extension bandage for a fracture of the thigh costs, with adhesive plaster, about 5 marks, while 300 gr. of Heusner's adhesive fluid, with which five bandages can be constructed, can be obtained from any chemist for 2 marks.

(2) It can be quickly applied. Heusner's bandage is in position in a short time—within a few minutes—a thing not possible, even in trained hands, in using adhesive plaster.

(3) It can be easily taken off without giving rise to any unpleasant symptoms whatever.

Just this last peculiarity is of special value. Anyone who has had the doubtful pleasure of taking off an adhesive plaster bandage in a sensitive person, even with the help of free use of æther or benzine, will be astonished at the ease and comfort with which the strips can be taken off after cutting through the encircling bandage.

We have used the resinous adhesive bandage in our large fracture department for more than a year, since Herr Geheimrat Heusner had the goodness to demonstrate it to us in person, for all fractures of the lower limb, and we are very much gratified by the result.

We are persuaded that it forms a great advance on the technique of the extension bandage, and we can, therefore, recommend it most pressingly to our colleagues, whether in private or hospital practice.

In using Heusner's resinous adhesive bandage, the possibility also presents itself of strengthening the action of the pull by means of a small modification. This is desirable in fractures of the lower half of the leg accompanied by considerable shortening. The usual extension bandage, whether it is applied in Heusner's way or in the way usual with us formerly, does not in this situation suffice to fully make good the shortening. The surface for attack at the lower fragment is too short to afford an adequate pull, and the instruction to apply the circular plaster strips as far as beyond the ankle does not much alter matters.

My method is to carry a narrow strip of felt above the malleoli round the leg and to sew it at the side with exactitude to the long strips of the Heusner's bandage; anteriorly on the extension side the ends are united by a few stitches.

By this arrangement the lengthways pull surrounds the ankle like a cuff, and, naturally, exercises in this way a considerable force of pull.

I have succeeded by this method in completely removing the shortening in a series of spiral fractures and supra-malleolar fractures of the leg; I would, therefore, recommend it for adoption in suitable cases, though I would mention that extraordinary care must be taken with regard to decubitus.

* To be obtained from the instrument makers, Vogel-Grevenberg, Köln, Herzogstrasse; price 8 marks.

Remarks

ON

FURTHER EXPERIMENTS CONCERNING THE ORIGIN OF LIFE.*

BY

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My work entitled *The Origin of Life* was based in the main on 196 experiments with hermetically sealed tubes whose contents had been exposed to high temperatures.

Since the date of its publication in the spring of 1911 I have performed a much larger series of experiments, as many as 280, and consequently should be in a position entitling me (1) to pass some judgement on the value of my previous results; (2) to deal more or less authoritatively with the doubts expressed by others as to the validity of my conclusions; and (3) to offer some useful advice to those who may wish successfully to repeat my experiments.

1. The Nature of the Problem and the Extent to which it has been Solved.

It has long been widely believed in the world of science that the occurrence of "spontaneous generation" is a myth.

This view gathered strength thirty to forty years ago, seeing that the experiments of Pasteur, and later those of Tyndall, induced them to urge it with much insistence; and because, moreover, it has seemed to be in accord with the practice found needful in bacteriological inquiries of growing importance.

In all their experiments Pasteur and Tyndall, as well as previous experimenters, made use of solutions of organic matter—mostly infusions of different kinds—heated to 100°–105° C. for varying periods, and subsequently protected more or less securely from external contamination. All these solutions or infusions must have been more or less teeming with bacteria of different kinds, as well as with torulae and germs of common moulds. This would have been notably the case with hay infusions, which were so largely used by Tyndall.

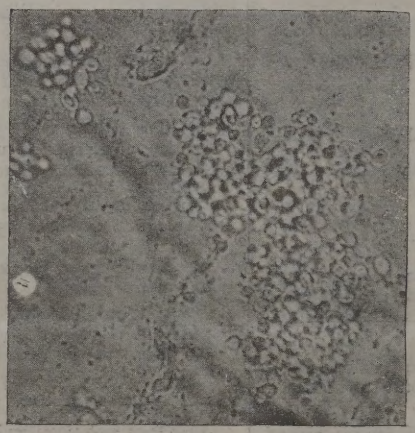

Fig. 1.—One of several groups of small torulae beneath the same cover-class, as taken direct from a tube exposed to light containing a yellow solution, which had been heated seven months previously to 100° C. for twenty minutes on three successive days. × 700.

These experimenters made no attempt whatever to exclude such organisms and their germs. They trusted to what was known and well established concerning the lethal influence of heat on living matter immersed in fluids, and consequently to their ability to sterilize the solutions and vessels used.

Having extinguished all life in their media and receptacles, they exposed them for varying periods to what were considered suitable incubating temperatures. Then, if evidences of fermentation showed themselves within the experimental fluids, they were seemingly content to account for it as a result of some error; while their numerous negative results impressed them so strongly that they were induced to favour a general conclusion far wider than was warranted by their premisses.

My own experiments have been of the same order, only much more stringent, seeing that instead of infusions of organic matter I have of late been dealing with saline solutions only, always contained in hermetically sealed vessels, and, moreover, often heated to temperatures very much higher than those employed by my predecessors. My saline solutions have also contained some bacteria, toruloid corpuscles, and germs of mould, though probably very much fewer than those existing in the organic infusions dealt with by Pasteur and Tyndall, whose experiments have been believed to be so decisive.

Thus, if from the basis of their negative results they felt themselves warranted in proclaiming their belief that the present occurrence of "spontaneous generation" was a myth or chimera—a view which has been so widely accepted—how much stronger is my warrant for the opposite belief, looking to the very numerous occasions on which, when opening previously sterilized tubes and solutions, I have taken therefrom undoubted living organisms.

Even one such positive result free from all error is, of course, worth more than any number of negative instances. It will be well to consider, therefore, the various possibilities of error that have been suggested.

2. Reply to Criticisms.

Some of my critics—mostly not biologists, and presumably not thoroughly acquainted with bacteria and torulae—have supposed that what I have taken from my tubes have been mere pseudo-organisms such as Leduc, Herrera, Jules Félix, the brothers Mary, and other plasmogenists are able to produce from various saline solutions—bodies which undoubtedly often simulate organic forms with great exactness. This, however, is an absolute error not likely to be shared by biologists, and one which is shown to be erroneous by the fact of the free multiplication of my organisms when taken from their own media and introduced into other quite different nourishing fluids.†

Others do not doubt that the organisms found and photographed are real organisms, but cannot believe that they have really been engendered within the tubes.

Some of these suggest that the organisms found have rushed into the tube from the atmosphere when its neck has been filed off. But there is practically no inrush of air at this time; certainly none that would suffice to carry atmospheric germs at once through the fluid (about 1½ in. deep) to the sediment at the bottom of the tube, where the organisms are always found.

Others suggest that the organisms may have been contained in the pipette; but this is always thoroughly heated in a spirit lamp flame just before it is introduced into the freshly-opened tube. And when a small quantity of the sediment is obtained by the pipette, it is at once transferred to a thoroughly clean microscope slip and covered with a cover-glass.

Then torulae are supposed by some of my critics to fall from the atmosphere on to the drop of fluid on the microscope slip, during the moment or two that it remains uncovered. This supposed explanation, however, of the presence of organisms found by me is mere unsupported theory, as any one would soon find who set himself to discover torulae in the way suggested, and by an examination of Fig. 1. That such formed organisms, and often in such numbers, could have been gathered from the atmosphere during the transit of the pipette for one or two feet from the mouth of the tube to the microscope slip, and before the drop of the solution is covered is, in fact, devoid of all probability, and will be shown to be so by the numerous cases subsequently to be referred to in which, during similar examinations of various series of other tubes (barren), no organisms whatever could be found.

Other critics are content to assume that the organisms found are not living. They believe them to be dead organisms, some of those pre existing in the experimental fluids, but killed by the heat to which they and the tubes have been subjected.

This objection requires to be looked at in more detail, because it is admitted that some few organisms may be found in the experimental fluids, derived from two of the constituents of such solutions—namely, the sodium silicate and the ammonium phosphate—the dilute phosphoric

* Paper read before the Pathology Section of the Royal Society of Medicine on November 19th, 1912.

† Solutions of 3 per cent. glucose and of 5 per cent. cane sugar, as well as the ammonic tartrate solution referred to in *The Origin of Life*, p. 39.